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OCTOBER 1946

SCIENCE NEWS

Picture of the Month 65
Probing the Upper Air 73
Rocket Camera to Shoot Sun 78
The Weirdest Danger in the World 86
Plastic News 91
New Microscopic Horizons 126

SCIENCE AT WORK

More Power on Wheels 66
Washing with Sound Waves 74
Telephone that Talks Back 93
Steel by Prescription 103
3,000-Pound Hammer 126

PSM FEATURES

Odd Jobs for Odd Hours 98
Quiz Bird 102
How a Sign Is Painted 108
Old-Time Tools Tell History 115
For Fun and Hard Knocks 125
Adsorption Is the Word 200

AVIATION

Saboteur Container 73
Flying Duplex 75
Biggest Bomber 81
Rocket Bomb's Forerunner 81
Machines to Help Pilots 82
Parachutes for a Test Plane 84
Red Light on Stalls 84
"Casing" Clouds for Safer Flying 94
Beechcraft Bonanza (Pin-up) 97
How to Live at High Speed 121
Planes That Never Fly 128

AUTOMOBILES

Ever-Clear Windshields 92
More Car in Less Space 132
Aluminum Car Weighs 800 Pounds 139
Gus Wilson Delivers a K.O. 140
Prevention of Gas Loss 143
Jeep Station Wagon 143
Is Your Car an Oil Hog? 144

INVENTIONS

Push-button Parking 85
Camera Transit 92
New Ideas from the Inventors 110
I'd Like to See Them Make 114

PHOTOGRAPHY

Printing Color Through a Bull's-Eye 100
Autumn's Colors Make Colorful Photos 113
Keeping Print Tongs in Glass Jar 186
Homemade Film-tank Agitator 186
Storing Cut-Film Hangers 186

MECHANICS & SHOPCRAFT

Indicating Inside Calipers 174
Tailstock Live Center 177
Auto-rim Clamps Hold Work on Lathe 178
Drilling on a Diameter 178
Grinding Hexagonal Surfaces 179

(CONTINUED ON PAGE 4)

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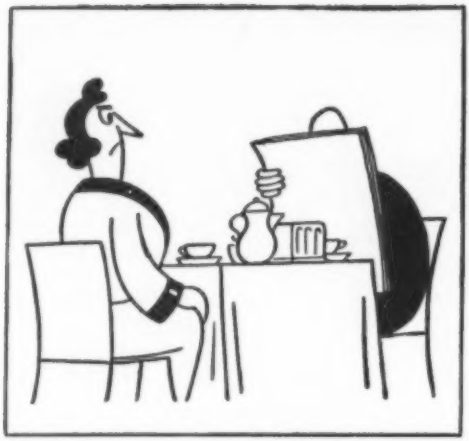

Versatile Cutting Tool....179
Compass Used as Pattern Wheel....198
Flat Paint on Radiators....199

HOME MECHANICS & HANDICRAFT

Craftwork Projects of the Month....112
New Gasoline Stove....138
Turn Wagon Wheels to Profit....148
Whittle It from Soap....151
Garage Basketball Backboard....153
Table Stand for Electric Saw....153
Plastic Jewel Case....154
Signature Lapel Pins....154
Sky Climber....156
How to Position Prop Blades....158
Home Sweet Home—But Is It Safe?....159
Souvenir Shells Form Table Legs....161
How to Sheathe a Roof....162
Ten Uses for Typewriter Spools....168
Model of Pioneer Locomotive (Part II)....170
Inspection Scope Has Own Light....180
Lightning in Your Hand....188
Alcohol Blowpipe....198
Combination Steps and Chest....199
Centrifuge from Discarded Fan....199
One-Car Garage Is Spread Apart....204
Portable Workshop Lamp....204
"Shove Buggy" Speeds Tractors....205

RADIO & ELECTRICITY

Lamp That Talks....92
Copper-Lined Radio Test Room....120
Making Radio Weather-Conscious....127
Raser to the Rescue....134
Safety Circuit for Transformers....193
Induction-Motor Reversing Switch....193
Tree-Fork Pole Supports Wires....193
Midget 80-Meter Transmitter....194
News in Electronics....196

DEPARTMENTS

Voice of Science....7
Letters....16
March of Science....126
Modern Living....136
Auto Ideas....143
What's Your Ingenuity Quotient?....155
Keeping the Home Shipshape....166
New Tools....169
New Shop Ideas....178
Question Bee....203
Home Experiments....206
For Easier Farming....208
Editorial Memo....294

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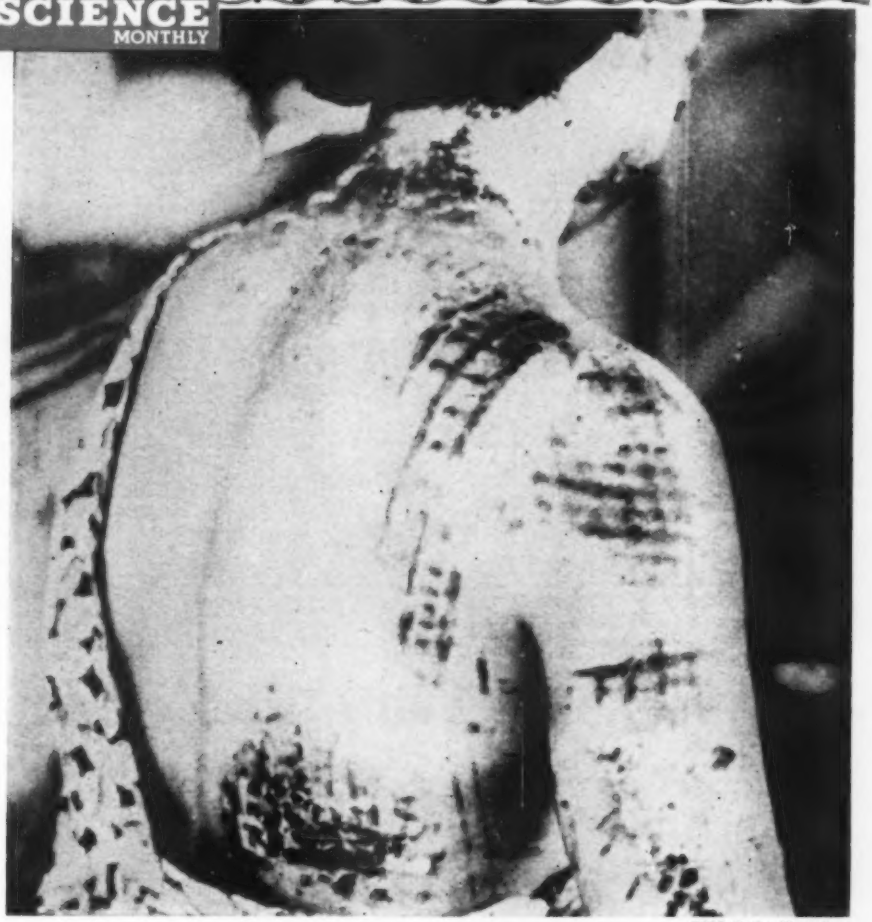

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Design for DYING

THIS is not a pretty picture. It shows the design of a woman's dress photographed on her flesh by the flash of an atomic bomb. It was taken from Japanese motion pictures made in a first-aid station in Hiroshima, but only recently released.

Why were these pictures withheld from the American public for a full year? Are we, the people who developed the world's final weapon, being shielded from its horrors?

Some of us have seen other pictures of what radiation does: men without eyes and ears, children with shriveled clumps of fingers that will never be hands. These were the survivors: the dead were ugly refuse.

We Americans should not be spared these sights. We need to be aroused in every way possible to the brutal truth that there is no defense in atomic warfare. Back from Bikini, Admiral Blandy himself has underlined this repeated warning of the scientists.

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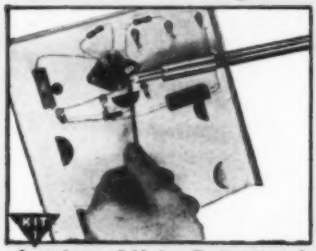
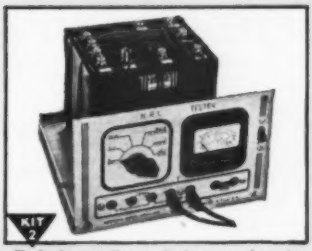
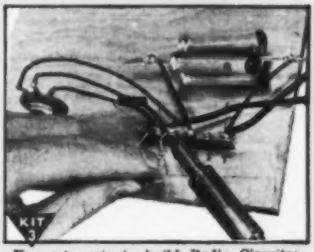


I send you Soldering Equipment and Radio Parts; show you how to do Radio soldering; how to mount and connect Radio parts; give you practical experience.



Early in my Course I show you how to build this N.R.I. Tester with parts I send. It soon helps you fix neighborhood Radios and earn EXTRA money in spare time.



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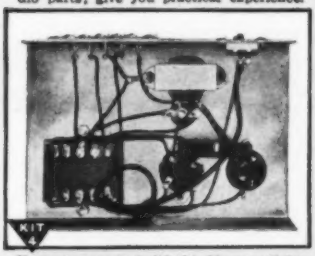

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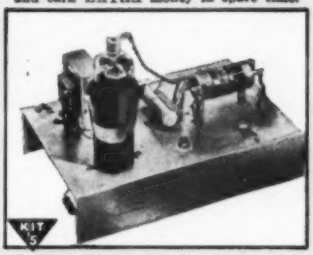

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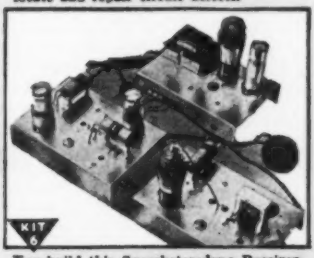

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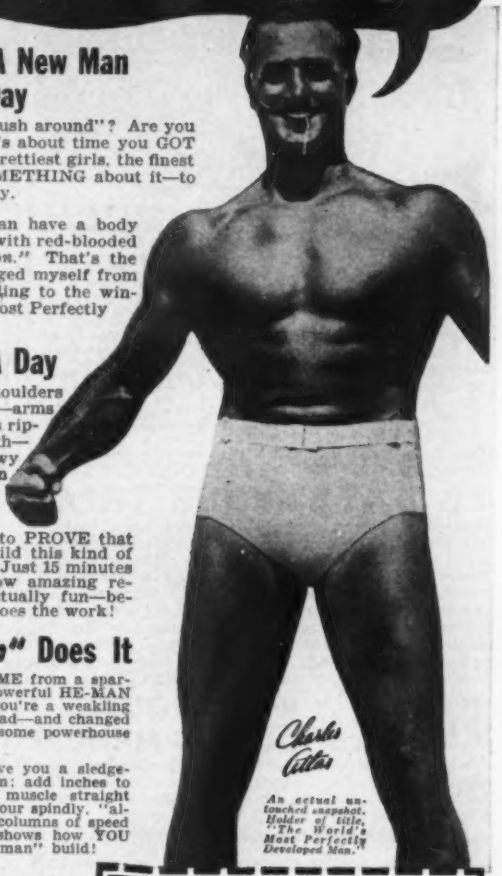

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LETTERS

How Old Is the Dial Phone?

Sir:

On page 103 of your August issue . . . an article states that the dial telephone is only 35 years old. I saw them over 40 years ago in Grand Rapids. They were not so compact as the phones of today, but they were dial phones.

L. R. COLVIN

Grand Rapids, Mich.

The idea behind the dial phone is almost as old as the telephone itself, and an automatic switchboard was actually used in Indiana as early as 1895. When PSM said there were no dial phones 35 years ago, it was thinking of regular service rather than isolated experiments. The first complete panel-dial central office in the Bell Telephone System was put in service at Omaha in December 1921.

An Unger to the Rescue!

Sir:

In a recent issue I noticed a letter from an L. Unger, Batavia, Java, N. E. I. He evidently got pretty hard hit by the Japs, and seeing that he is such an ardent reader of *Popular Science Monthly* I have rounded up all issues of the years 1942, 1943, 1944, and 1945 (which he was prevented from seeing), and want to ship them to him . . .

CHARLES F. UNGER

Sacramento, Calif.

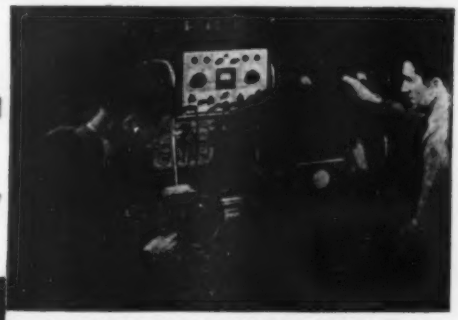
To generous Reader Unger of Sacramento, PSM promptly dispatched the street address of his bereft namesake on the other side of the world.

Non-Northern Lights

Sir:

I recently witnessed a display of *aurora borealis*, unusual to me in that the focal point of all streamers was directly overhead. . . . I would like to know if there are other

Learn RADIO-ELECTRONICS-TELEVISION



RADIO TESTING AND SERVICING—Students learning to locate troubles with modern radio analyzers.

ELECTRONIC CIRCUIT TESTING — Instructor showing students use of large Cathode Ray Oscilloscope.

TRAIN FOR A GOOD JOB NOW *one that offers* STEADY WORK *with a* REAL FUTURE

Don't be caught napping. Prepare for a good job now that will still be a **good job with a real future when** conditions change. If you are not a trained man you may have to **compete with millions of other untrained men. Get into a field that** offers real opportunities in good-times and bad-times. Tremendous expansion in **Frequency Modulation and Television is predicted** because of war time discoveries now being re-converted to civilian use. **Radio-Electronics** trained men **are needed today—they will be needed** in the years ahead!

"Learn by Doing"

RIGHT HERE in the SHOPS of COYNE—in a Few Weeks

Student Finance Plan

We train you on real Radio, Television and Sound equipment—RIGHT HERE IN THE COYNE SHOPS IN CHICAGO. **Whether or not you have had Radio experience you need Coyne all-around Radio Electronics training.** Many of my students had no previous experience. Others had experience in one or two branches but **realized they needed all-around training for better jobs and advancement.**

EARN WHILE LEARNING

If you need part-time work to help pay living expenses while at school, we will help you **get it. Coyne** graduates also receive a **Life Membership** with **Lifetime Employment Service,** free technical service and privilege of review without additional tuition charge.

MEN WITH PHYSICAL DISABILITIES—whether due to war or other causes—we also have facilities for you. **Check coupon for particulars if you have a physical disability of any nature.**

PREPARE FOR JOBS LIKE THESE

Frequency Modulation (FM)
Radio Manufacturing
Radio Set Serviceman
Television Servicing
Electronics Maintenance
Public Address Systems, etc.
Your Own Radio Shop
Industrial Electronics and Electric Refrigeration Now Included

ADDED TRAINING This training included to help you get ready for the better jobs in these great fields

THE HOME OF COYNE

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Prepare for jobs as assembler, inspector and tester—Radio sales or service and installation work, electronics, television, sound work, aircraft-radio, auto-radio, etc. Many opportunities in the vast **Radio-Electronics** field.

GET MY BIG NEW BOOK

It tells all about my big Chicago shops and **my plans to help you get ahead.** Packed with facts and pictures of students at work in my shops. **Mail coupon for this Big New Book now!** Coupon will also bring details on how **I'll finance most of your tuition** . . . facts on how I help you "Earn-While-Learning" . . . information on FREE EMPLOYMENT SERVICE FOR LIFE . . . and other plans to help you. ACT NOW TO MAKE SURE YOU GET MY GENEROUS OFFER. Sending for this interesting free book can be **your first big step to success. No obligation. No salesman will call. Mail coupon today.**

B. W. Cooke

B. W. COOKE, Dir., Radio-Electronics Div., COYNE ELECTRICAL SCHOOL
500 S. Paulina St., Dept. 76-4H, Chicago 12, Ill.

Dear Mr. Cooke: Send me your Big Free Radio-Electronics Book and all the facts . . . also full details of your **"Student Finance" plan.** ☐ Send special G. I. Bulletin.
☐ Send physical disability details.

NAME.....

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B. W. COOKE, Dir. Founded 1899

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500 pages 900 illustrations and diagrams

SHOWS YOU HOW EVERY STEP OF THE WAY!

Covers alternating—and direct-current motors, synchronous motors and generators and BOTH mechanical and electronic motor control systems. Quick-reference guides at end of every chapter show exactly how to handle specific jobs. Invaluable for either beginners who want to learn HOW—or for actual bench use in busy repair shops.

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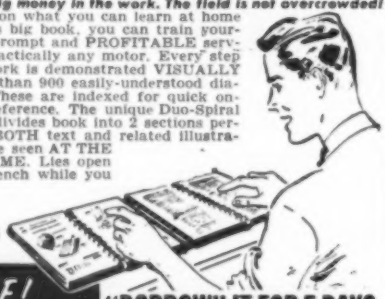

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records of such displays, as all those I have seen heretofore seemed to have their focal points in the northern skies.

MARTIN HAWRYLOW

Oshkosh, Wis.

Many examples of the corona aurora, *as it is called, have been recorded. The focal point is generally centered on the magnetic zenith, but the earth's curvature produces the illusion that it is directly overhead.*

With Pleasure

Sir:

The Department of Marine Engineering of the United States Naval Academy is revising its text on engineering materials and processes. . . . It is desired to include illustrations of the open-hearth furnace and blast furnace. I notice sectioned perspective illustrations of these two furnaces framed here at Carnegie Tech with a Popular Science credit.

If from this description of the illustrations you can find a copy suitable for reproduction . . . I would appreciate having it.

B. F. BROWN
Lieutenant, USNR

Pittsburgh, Pa.

Proud and happy to be of service, PSM has sent the pictures to Lieutenant Brown.

Heaven Forbid!

Sir:

When I saw the umbrella that permits use of both hands (PSM, June '46, p. 102), the first sensation that swept over me was that it would go over big as a woman's hat.

ROGER DITTMAN

Van Nuys, Calif.

Correction

Sir:

We are manufacturers of . . . Lite-A-Lok, described in your August edition. However, your item said that the Home Products Co. was of Chicago rather than Adrian, Michigan . . .

CARLTON HENRY
Manager

Adrian, Mich.

PSM's apologies to the Home Products Co. and to Chicago's postmaster.

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Send me both your big book "VICTORY FOR YOU" and Kit Supplement, showing how I may make my start in Radio-Electronics with your modern A-B-C home training plan. No obligation.

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GET THIS FREE BOOK!

This new 128-page book, "Stammering, Its Cause and Correction," describes the Bogue Unit Method for scientific correction of stammering and stuttering—successful for 45 years. **Benj. N. Bogue, Dept. 1890, Circle Tower, Indianapolis 4, Ind.**

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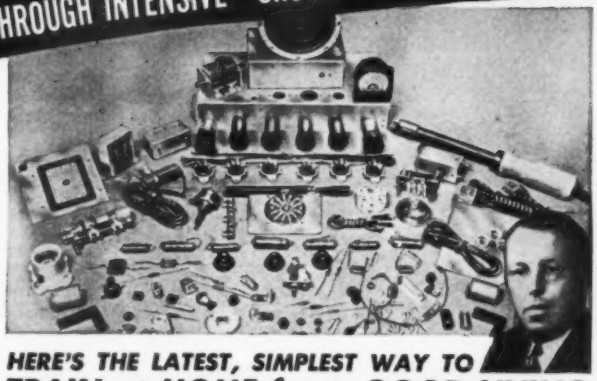

YOU DO EXPERIMENTS, CONSTRUCTION, TROUBLE-SHOOTING

I'll show you how to perform over 175 instructive Experiments—how to build countless Radio Circuits. You'll learn a new, fast way to test Radio Sets without mfg. Equipment.

I give you a fine, moving-coil type Meter Instrument on Jewel Bearings—with parts for a complete Analyzer Circuit Continuity Tester. You learn how to check and correct Receiver defects with professional accuracy and speed.

You'll get valuable experience and practice building this Signal Generator and multi-purpose Tester. Makes a breeze out of fixing Radios and you don't have to spend money on outside, ready-made equipment.

Soldering, wiring, connecting Radio parts . . . building circuits with your own hands—you can't beat this method of learning. When you construct this Rectifier and Filter, Resistor and Condenser Tester, etc., you get a really practical stint on Radio that leads to a money-making future.

HERE'S THE LATEST, SIMPLEST WAY TO TRAIN at HOME for a GOOD LIVING in RADIO-ELECTRONICS & TELEVISION

I train your *mind* by putting you to work with your *hands* on a big 6-Tube Superheterodyne Receiver. And, believe me, when you get busy with real Radio Parts — 8 big Kits of them — you really LEARN Radio and learn it RIGHT! You get the practical stuff you need to be *useful* in Radio, and that's what it takes to make money. You don't have to worry about what to do with these 8 Kits of Parts. Step by step, I show you how to build circuits, test, experiment, trouble-shoot. And you don't need any previous experience. The Sprayberry Course starts right at the beginning of Radio! You can't get lost! Simplified lessons, coupled with real "Shop" practice, makes every subject plain and easy to understand and remember.

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(Mail in envelope or paste on penny postcard)

Expert Television Technician, Bob Cohen, using $625.00 RCA Sweep Generator to check television set for engineering inaccuracies. It is expected that television test equipment will be reduced in cost as the television industry gets into its stride.

Individual instruction is necessary in teaching television. Here an instructor helps a student. Each student must build 7 radio sets before he is allowed to start on a television set.

THEY BUILT THEIR OWN

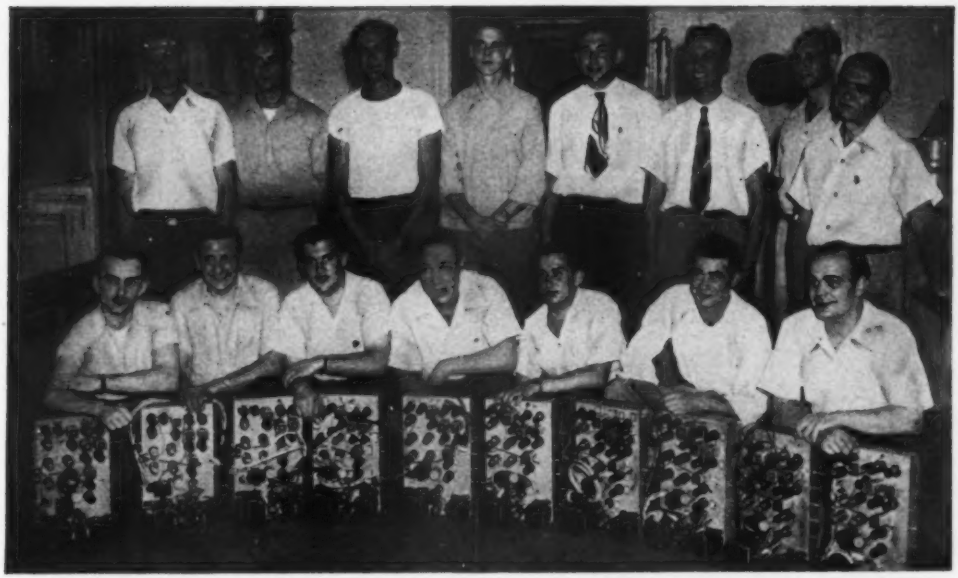
MANY veteran students are now attending N.Y.T.I. of N.J. under the generous provisions of the G.I. Bill of Rights, which allows any approved school of the veteran's choice to charge the Veterans Administration up to $500 a school year against the educational expenses of qualified veteran students. Full-time students, with dependents, are also paid a subsistence allowance of $90 monthly by the VA, and those without dependents, $65. Many students hold part-time jobs, thus augmenting their monthly payments. However, you do not have to be a veteran to be accepted as a student.

A considerable number of out-of-state students attend the school because of its excellent, practical type of radio and television courses, so difficult to get anywhere else in the world today. Living quarters are obtainable by single students, but married students report considerable difficulty in finding quarters for their families.

Student Walter E. Stevens, making engineering checks with $395.00 United States Television Sweep Generator. The school is lavishly equipped with the most advanced test equipment.

No high-school diplomas are required. Every student must have at least a grammar-school education, however. And the school requires that a student be earnest, sincere and technically inclined. Students without proper mathematical backgrounds are taught the radio and television mathematics they need.

You probably have been wondering what N.Y.T.I. of N.J. means. It stands for the New York Technical Institute of



An Advanced Class in Television at N.Y.T.I. of N.J., famous television school, and the 17-tube television sets they built. Students at this school have been building television sets as part of their courses since 1939, when television programs were first broadcast regularly. School officials found that this practical method of instruction is productive of very satisfactory results. Each student may build a set and keep it to use in his own home laboratory, if he chooses to. The school is located in the heart of the radio, television, electronics industry.

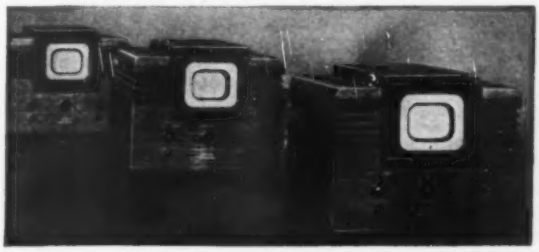
TELEVISION RECEIVERS!

New Jersey, a resident school located in Newark, N. J., just across the river from New York City (Only 20 minutes from Broadway by subway or train). The school is located in the heart of America's great radio and electronics industry. Such leading television, radio and electronics manufacturers as Western Electric, Du Mont, Federal and Edison are nearby. Newark also is near Radio Stations WJZ, WEAF, WABC and WOR; each a leader in broadcasts going on networks all over the country. This means that the school offers numerous advantages, as it is in touch with most recent developments in radio and television. This also means that qualified radio and television engineers are available to the school for teaching purposes.

During the war N.Y.T.I. of N.J. was approved for the training of Signal Corps personnel by the Army. When the war ended the enrollment increased because of the influx of veterans desirous of getting practical television training. At the present time, there are 120 openings for new students for the several classes beginning in October & November 1946.

The school issues a special Bulletin, Numbered 310, which illustrates and describes its facilities and equipment and shows students using its varied laboratory equipment. Bulletin 310 also describes classes that may be attended, housing conditions, costs, hours, etc. To get complete information write for Bulletin 310 (for which no charge is made) to the New York Technical Institute of New Jersey, 158 Market Street, Newark, New Jersey.

A line of RCA television receivers used for comparative test purposes at N.Y.T.I. of N.J.



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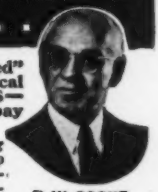

B. W. COOKE
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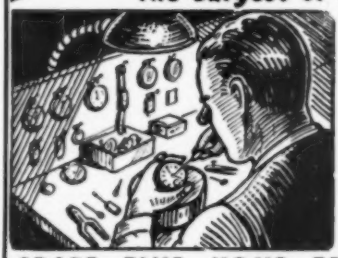

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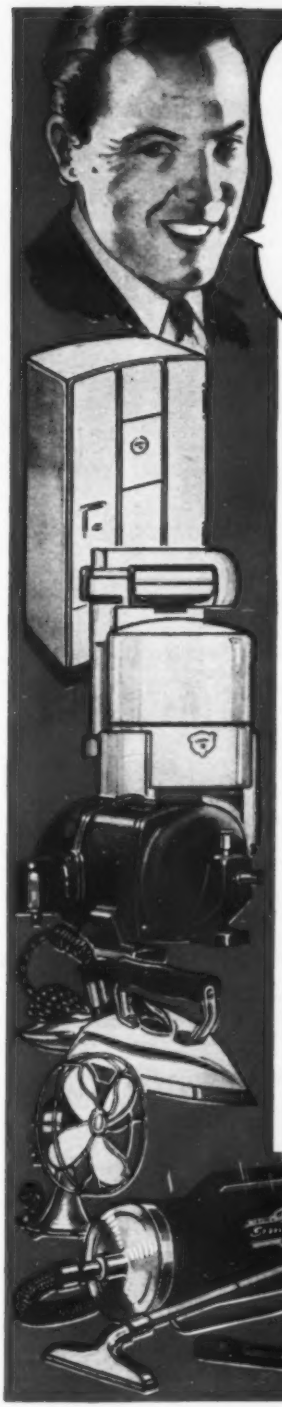

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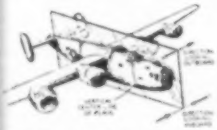

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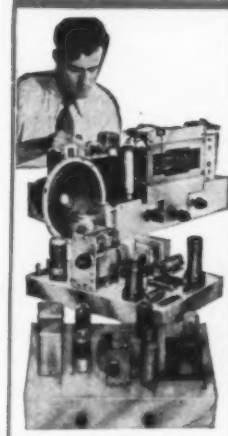

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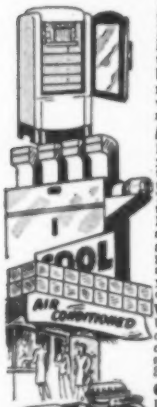

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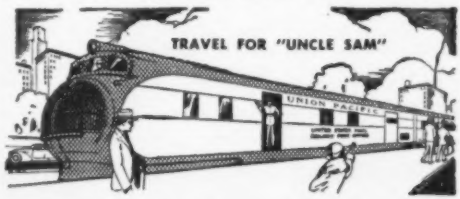

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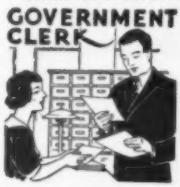

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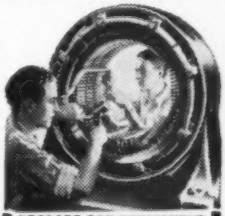

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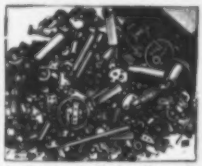

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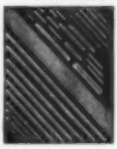

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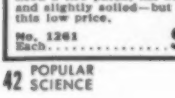

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BIGGEST $1.00 value in 35 MM finishing today. 36 exposure fine grain $3\frac{1}{4}$x$4\frac{1}{2}$ enlargements; deckled, embossed margin and date. Eighteen exposures 75c; 18 exposure splits 55c; 36 exposure reloads 50c. Special: return this ad with $2.00 and we will send five 36 exposure reloads. Free mailers. 8 exposure rolls in beautiful, deckled contact finish with embossed wide margin, 25c. Mailbag Film Service, Box 5440-A, Chicago 80.

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PHOTOS Enlarged: Oil-colored. 8x10 $2.00. Gnilrad Photos, 812 Barry Avenue, Chicago 14, Illinois.

COPY your favorite Photos or snapshots. Prices. 5x7 0.75. 8x10 $1.00. Enlargements only 5x7 0.25, 8x10 .50. Minimum Copy .50. Black and White prints made from Kodachome Slides. Phototking Supply Shop, 6803 N. Clark St., Chicago, 26.

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LEARN at home "Working with Plastics". Full information on sheets, blocks, rods, tubes. Trade names, sizes, colors for fabrication. Designing, tooling, bending, cementing, polishing. Also for homework-shop. Only $1.25 postpaid. Money back guarantee. Modern Technical Book Co., Dept. M.S. 55 West 42nd St., New York 18.

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AGENCY resale Plan, Craftsman's catalog, 10c. Technicraft, 1156 Commonwealth, Boston 34, Mass.

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INEXPENSIVE home-made printing press. Details free. Novelty Shop, Downsville, Louisiana.

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AMAZING Radio. Operates free. Positively needs no house current, no batteries. Has no tubes. Remarkably, requires no ground connection and no lengthy old-fashioned aerial. Has Specially Designed, Radio Impulse Receptor, 6½ ft. sq. Receives local standard broadcasting stations. (Exciting long distance reception at night.) Radio gives headphone operation for personal use. Has excellent tone; adequate volume, sensitivity and power of selectivity. Exceedingly simple to operate. Can be built even by teenage youngsters using wire and only a few ordinary, readily obtainable, reasonably priced, new or used parts. This practical radio sensation may well develop into an "Atomic Bomb Hit" amongst hobbyists, young and old. Be the first in your neighborhood to build and enjoy this thrilling radio. For all necessary plans and illustrations send $1 to: Paul Seman, Dept. 5, 527 Fred St., Whiting, Ind.

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MUSIC of Distinction composed to your song poem by Francis Martin, 720 Washington St., Delphi, Indiana.

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BOWS-Arrows for Recreation-Hunting-Fishing. Beautiful Archery instruction book. 70 pages. 50 illustrations, only 50c. Illustrated catalogue Free. Archery Sales-Service, 617 South State, Chicago.

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THE NATIONAL JOY SMOKE

POPULAR SCIENCE MONTHLY
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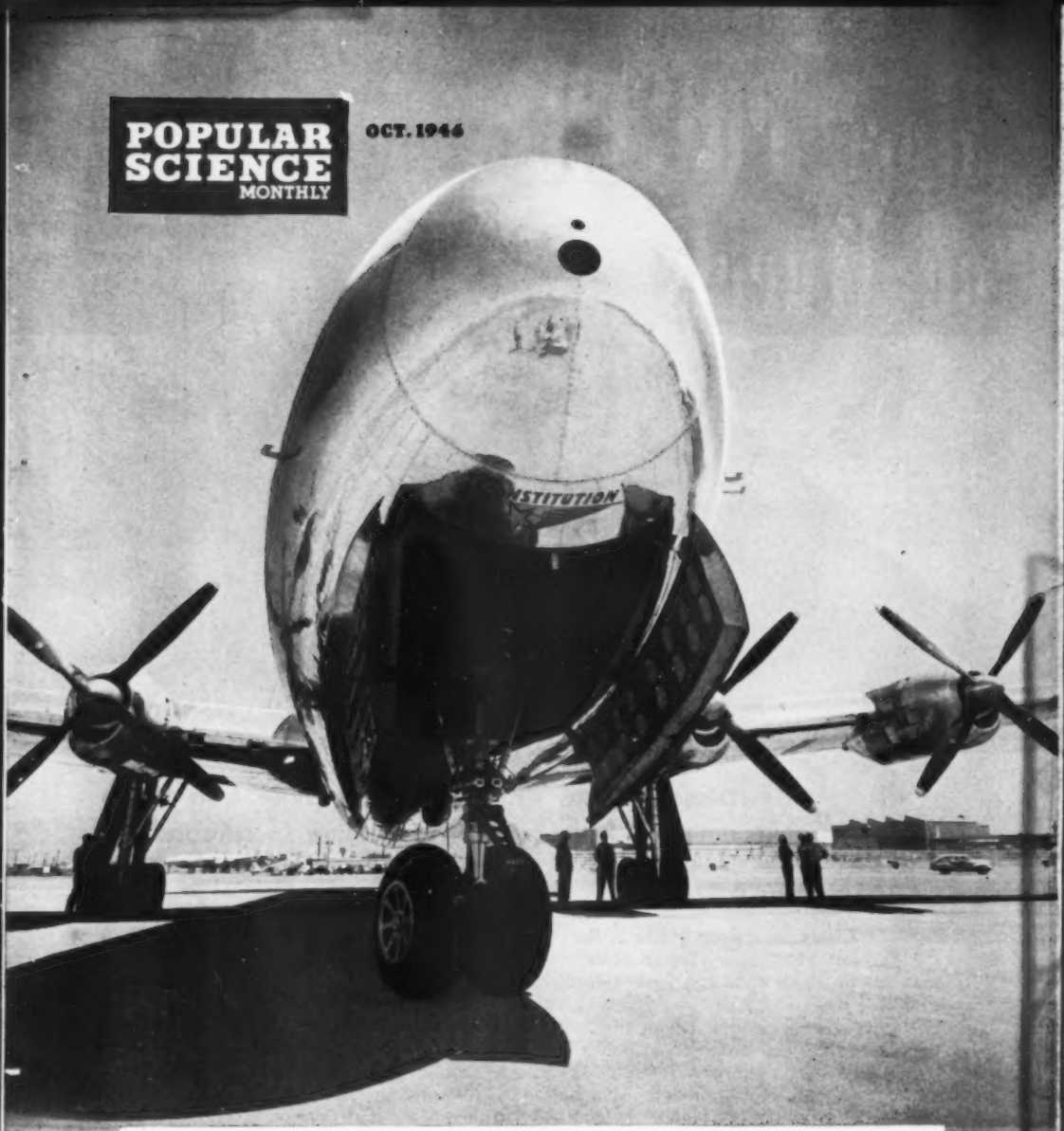


Bow of a New Constitution

Outweighing its closest competitor (the 72-ton Douglas Globemaster) by 40,000 pounds, Lockheed's Constitution, biggest land-based transport (see page 75), squats on 10 wheels. Eight are tandem-paired main wheels; the other two are the nosewheels, which retract into the gaping maw above.

More POWER on Wheels

Diesel, steam or turbine, a huskier Iron Horse emerges from a quiet revolution in railroading.

By DEVON FRANCIS

AT THE foot of a steep grade in the Allegheny Mountains a bunch of railroad men sat on their haunches in a semicircle the other day looking dubiously at a spanking new Diesel-electric locomotive. The engineer in the cab proposed to pull a long string of passenger cars over the ridge ahead without "double-shotting"—without a helping locomotive. It had never been done before on this grade.

"You'll never make it!" yelled one of the onlookers to the man in the cab.

"Want to bet?" the engineer yelled back, adding some picturesque expletives.

He eased open the throttle. The cars obstinately braced themselves as the Diesel muttered heavily. The wheels moved, snail-like at first and then with increasing assurance. Up the grade went the train, over the top of the ridge.

Another bit of railroad history had been made, without fanfare.

At the head of that string of cars was one of the new postwar locomotives, product of an effort to put more power on wheels to pull greater loads faster on the 228,000 miles of the nation's rail system. Produced at the Schenectady, N. Y., shops of the American Locomotive Company, it develops 2,000 horsepower in one unit. A unit, in railroad parlance, is a single frame or car.

In building that much horsepower into a unit, Alco had done nothing to awe the casual railroad passenger. The Baldwin Locomotive Works at Chester, Pa., had, in fact, done even better. Into another postwar Diesel-electric it had crammed 3,000 horsepower. Two of the Baldwin units hooked together produce 6,000 horsepower, as much as a mammoth steam locomotive.

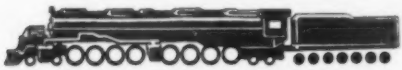
These lusty locomotives looked like any other Diesels. Yet the 2,000-horsepower job was unique under its shining steel skin. The reasons were subtle. They could be fully grasped only by railroad men interested in getting more goods and people from one

2-8-8-0 type (16 drivers), generally used to haul heavy coal and ore trains where grades are steep.

0-4-0 type switcher is used for light switching on industrial tracks where clearances are restricted.

4-8-8-2 oil-burner, used only by Southern Pacific, seems to go backward. Cab is ahead of boiler.

2-8-8-4 type is the "Yellowstone," so named because it was first put in use by Northern Pacific.



4-8-8-4 type is the "Big Boy," world's heaviest and most powerful. It is used only by the Union Pacific.

0-6-0 type switcher, a versatile performer, finds employment in passenger and freight service, too.

4-6-4 Hudson type, today's most popular high-speed passenger engine where hills are moderate.

2-8-8-2 type wins its greatest popularity in hauling heavy-tonnage trains in mountainous territory.

A-B-C-D Diesel-electric locomotive. The Rock Island owns this 5,400-hp. engine

From "Giants of the Rails," by S. Kip Farrington, Jr.; Garden City Pub. Co.

point to another faster and at lower cost.

To the public, the rash of new locomotives meant only a lot of good-looking chrome and a saving in time. The passenger wasn't aware that he had a front-row seat at a revolution in rail transportation's prime mover, the locomotive.

It had to come. Even discounting the growing competition of the air lines, the railroads were in for a housecleaning. The weight of freight and passenger trains had almost doubled in two decades. Freight speeds had increased by half, the pace of passenger trains by a fifth.

So U. S. locomotive makers were badgered by the railroads to produce something better. Out of their researches have come several conclusions:

The Diesel-electric is far from reaching the peak of its efficiency.

The steam locomotive, an object of sentimental attachment to railroad lovers the world over, is still in there chugging—has only begun to realize its potential power.

Locomotive improvement, in the light of atomic power, may be at a threshold rather than an end.

The fundamental problem in locomotive design is that of packaging power. A locomotive built to negotiate every mile of standard-gauge track in the United States can be no more than 15 feet 2½ inches high, 10 feet 6 inches wide and 115 feet long. Into a space approximately that size in a steam locomotive (articulated Diesels can be longer), designers have to squeeze as much power as is produced by stationary power plants covering a city block. Track clearances, curves and weight limits forbid making locomotives much bigger.

The Diesel-electric is, of course, the most beribboned package on the shelves of the locomotive makers. It has no peer as a switching engine and in some respects as a road engine. It is reliable. It is powerful. It doesn't burn up fuel, as a steam locomotive does, when it is standing idle between jobs. It consumes practically no water.

Diesels for the road have almost doubled in number in the last two years. Most of these have been produced by the Electro-Motive Division of the General Motors Corporation at La Grange, Ill., while competitors were making steam locomotives by government directive. Today there are more than 5,500 Diesels on order or in service,

A locomotive is built around its frame. The frame on which this workman is sitting weighs 62,500 pounds and is cast and welded. Parts pictured on these two pages are not necessarily parts of "Big Boy," the giant shown in the panel below.

and 1,500 of these are road locomotives.

Until the advent of the Diesel, the fastest time between Chicago and the Pacific Coast by rail was 53 hours. The streamliners cut that to less than 40 hours. Next year the Diesels will lop eight hours from the Southern Pacific Sunset Limited's time from New Orleans to Los Angeles, and the Milwaukee Road will trim 18 hours from its Chicago-Seattle run.

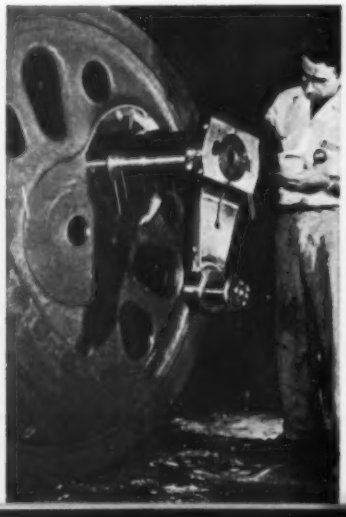
That isn't all a result of sheer speed. Steam locomotives are just as fast, but terminal delays lower their average.

Another advantage of the Diesels is their articulation. At any junction point a two-unit Diesel can be split in half to carry two parts of a train in different directions.

What damns the Diesel is its purchase price. If a steam locomotive costs $85,000, a Diesel-electric of comparable power will probably cost $200,000. A lesser disadvan-

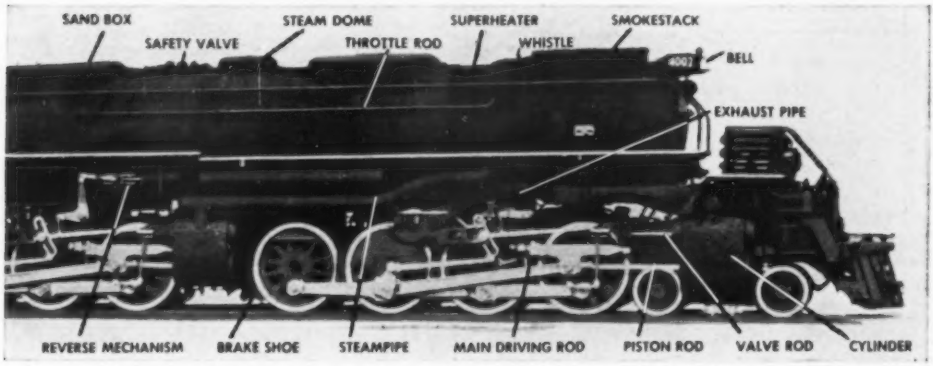
Engine power is transmitted to tender, and thence to a train, by the lower of the two bars shown below, at left. Five inches thick, it has a tensile strength of 47,000 pounds per sq. in. Upper bar is a reserve, to take load if the bottom one breaks.

Below, at left, is a 70-inch driving wheel, with counterweight opposite bearing. Rod that actuates piston valve attaches to small bearing on the end of L-shaped arm. To the right are a steam locomotive's pistons, grooved for rings as in a gas engine.



The parts of a locomotive tell many things about it. If there are small levers on the driving rods, as shown above, it means that the engine has old-style piston valves rather than poppet valves, which give greater efficiency at high speeds.

Behind the workman perched in the opening of this unfinished boiler are the superheater pipes where the steam is "dried" to increase engine efficiency. Pipe at right of boiler conducts steam to valve compartment and then to the main cylinder.



tage of the Diesel is its great weight and length. A steam locomotive a little more than 100 feet long, tender included, and weighing 465 tons develops 6,000 horsepower. For the same horsepower a Diesel must be at least 180 feet long and weigh, normally, 575 tons. Another minor drawback is that, while the Diesel consumes no water, it still must manufacture steam for heating purposes and for air conditioning. Providing a boiler big enough to make that steam is giving Diesel users some headaches.

The Diesel's large number of powered axles, on the other hand, give it a "tractive effort" that virtually eliminates wheel slippage and jerking.

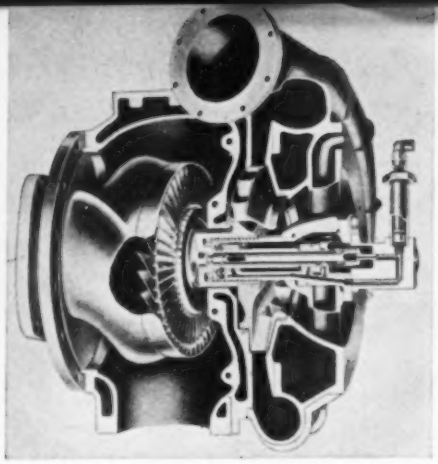
Basic to the railroads' demands for newer locomotives is the rivalry between companies. The railroads are almost womanish in fretting over the appearance of their locomotives. One road doesn't want engines that look like another's, so most steam locomotives are custom-built. The railroads can't do much about the appearance of the Diesels, though. They are as alike as peas.

Nonetheless, the Diesel is a slick competitive article to advertise to the public. The locomotive that went over the Allegheny ridge—sneak-tested on the rails of the Lehigh Valley—has gleaming stainless steel sides because the Santa Fe (see cover) ordered it that way.

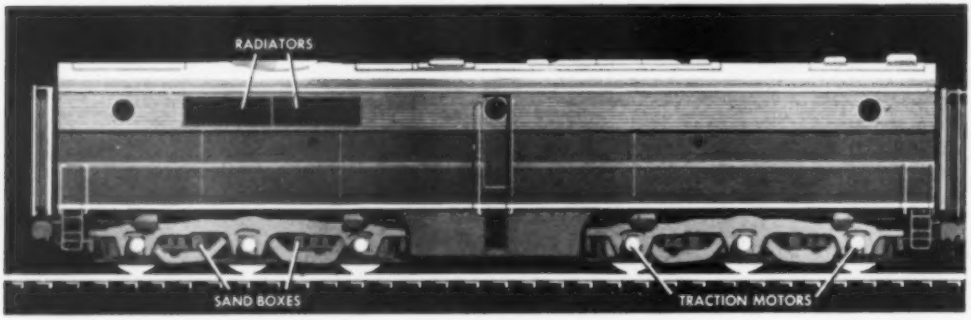
So, many more Diesels are being bought. The improvements in them hinge largely on putting more power in lighter single units on fewer wheels. On that basis, Alco claims that up to now it has the best of the breed.

The steam locomotive was written off as dead when the electric engine made its debut in 1893. A funeral oration was prepared for it again when, in 1934, the Chi-

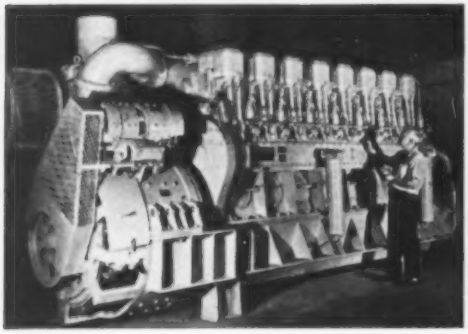
Each of a Diesel's blower-cooled traction motors, like the one above, is geared to two wheels. A 12-wheel Diesel like the typical A-and-B-unit engine below usually has four motors, four idler wheels.



Diesels, like aircraft, have superchargers to pack more air into the cylinders. In this one, the exhaust-driven turbine turns the blower at approximately 10,000 r.p.m. at full load and full speed.



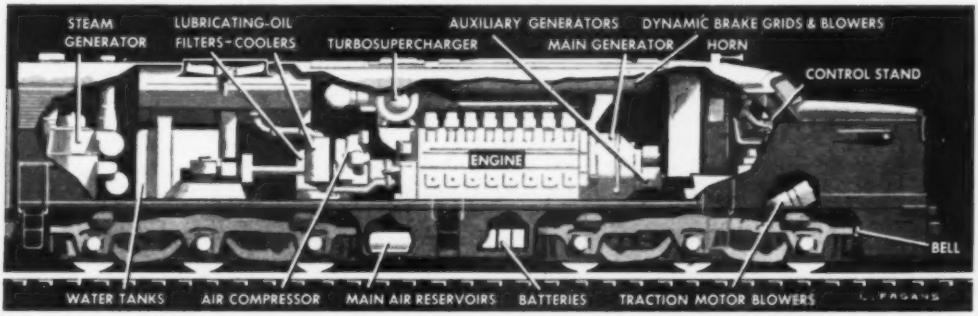
Below, an eight-cylinder, 1,500-hp. Diesel engine. Above it is the 4,515-pound crankshaft required by power plants this big. Engine itself weighs 38,500 pounds; generator, in foreground, 14,000 pounds.



This outsize piston indicates why excess weight is more of a problem in Diesels than in steam engines. It has a bore of 12¾ inches and a stroke of 15½ inches. The connecting rod is 31 inches long.

Uncrated after shipment to the locomotive factory, a generator awaits installation in an engine. The little generator on top is an "exciter" for its huge counterpart and supplies auxiliary power.

Diesel cabs are simpler than those of steam engines. Engineer holds throttle; air-brake handle is beyond his hand, reverse lever below it. The throttle in an A unit controls engines in all other units.



cago, Burlington & Quincy introduced the high-speed Diesel-electric road engine.

But the people who liked steam went right ahead, despite the frightful thermal inefficiency of steam (the ability to turn heat into mechanical energy), and today there are still 13 times as many steam locomotives as there are of all other kinds put together.

That's because thermal efficiency is a secondary consideration with the railroads. A steam engine gets only six to nine percent of the useful energy in coal as compared with a Diesel's 23 percent harvest from its fuel oil, but the steam engine's coal is cheaper. Steam, in fact, retains a slight edge on oil in operating costs.

There is an added and equally practical reason for the persistence of steam. The best freight customer the major railroads have is the coal-mining industry. Between rails and mining there is much mutual back-scratching.

But beyond that is the steady improvement in the steam engine. It has undergone refinements in combustion. It has more power. Baldwin's T-1 type consistently makes 85 m.p.h. on the open stretches for the Pennsylvania Railroad with a load of 15 passenger cars (some 1,200 tons), and betters 100 in spurts.

The manufacturers keep adding power by boosting the pressures and temperatures in steam boilers. Greater pressures are obtained with stronger boilers, higher temperatures by superheating the steam—leading it through pipes surrounded by the hot gases of combustion. That "dries" the steam. With dry steam more heat can be converted into mechanical energy.

Steam engines are getting more water and coal capacity, improved ash pans to reduce cleaning time, automatic lubrication of all wearing parts, and streamlining of all passages from boiler to exhaust to reduce losses in steam pressure. Welds are replacing rivets in boilers to reduce weight and maintenance. Roller bearings are being

added to cut friction, and the old-fashioned piston valve is being replaced with spring-loaded poppet valves, like those on most automobile engines, that offer an efficiency gain of 20 percent at high speed. Manufacturers are putting two additional cylinders on some steam jobs to reduce the strain on connecting rods and bearings and shorten the stroke.

So intent are the older locomotive makers on improving the steam engine that last year they established the Steam Locomotive Research Institute, which has nothing to do but make the product more acceptable to the railroads. It is not mere loose talk that locomotive boiler pressures may be boosted from 300 to 600 or even 800 pounds per square inch in the next few years. Pressures in some types of stationary and marine engines have, of course, gone far beyond that.

Horsepower Is Heavy

The bane of the steam locomotive is the inherent clumsiness with which it produces power. Producing one horsepower for one hour requires 15 pounds of steam. For 6,000 horsepower that's 90,000 pounds—and for every pound of steam there has to be a pound of water aboard. The water supply must be renewed every few hundred miles.

For that 90,000 pounds of steam some seven tons of coal must be burned, and the coal supply must be replenished, too. Finally, fully a quarter of the coal goes up the stack in smoke. The reason for that is the forced draft in the stack, induced by a blast of steam from the cylinders to hurry combustion. When coal burns too fast it isn't consumed.

But the steam lovers are even overcoming that. They are pumping jets of air into the firebox, burning up the residue, and reaping a public-relations profit of smokeless smokestacks.

While locomotive designers will argue over what constitutes a good engine, most of them agree that in the turbine they have a prime mover whose potentialities have barely been scratched. It produces more power from a given amount of coal. The Pennsylvania has a Baldwin turbine geared directly to the wheels. Baldwin now is making a steam turbine-electric locomotive, interposing generators and traction motors between the turbine and the drive wheels for greater power flexibility and more efficient turbine speeds.

What the railroads and the locomotive manufacturers would really like to see is a self-powered locomotive equal to the all-electric engine, which is far and away the most powerful and dependable thing on wheels. But electrification is astronomically costly and is undertaken only in densely settled regions or where electricity is cheap.

Wanted: A Coal Turbine

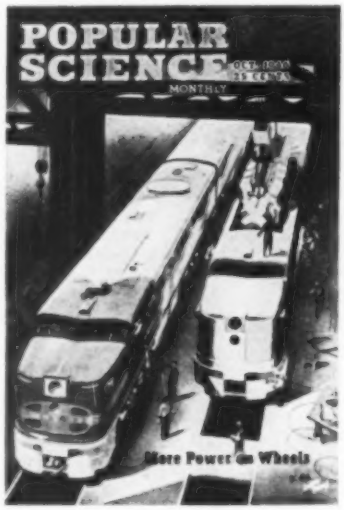
Failing that, the railroad men would like to get their hands on a gas-turbine locomotive, preferably operating on coal. That would eliminate boilers and fireboxes and obviate the bugaboo of higher Diesel fuel costs if the nation's petroleum reserves begin to dwindle. The coal turbine would use a fuel that exists in abundance.

That project is being co-ordinated by the Locomotive Development Committee, under the direction of Dr. John Yellott. No less than 17 projects are under way at a half-dozen institutions.

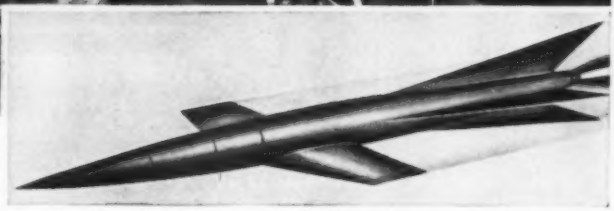
And then there is that ultimate source of power to draw the nation's trains that could make the railroads almost independent of either petroleum or coal supplies.

"There is no question in my mind," R. Tom Sawyer, of Alco's research staff, said recently before the American Society of Mechanical Engineers at Charleston, W. Va., "that the atomic-powered locomotive will be used on long, through runs eventually."

The atomic-powered locomotive will be just another version of the old Iron Horse. It probably will use steam.



THE COVER: A new 2,000-hp. Diesel-electric rolls out of Alco's Schenectady shops as engine is lowered into another. Painting by Lester Fagans.



Lead-incased Geiger counters in Army's B-29 Flying Laboratory are gathering facts on cosmic rays at heights up to 35,000 feet.

Probing the Upper Air. A number of rocket projectiles like the stub-winged one above (inset) are being built for the Army to gather data on cosmic rays and other little-known radiations. Carrying instruments to ultra-stratospheric levels, they will supplement findings made by the B-29 Flying Laboratory at lower altitudes.

Guided Missile. "Gapa," a rocket weapon built by Boeing for the Army, is discharged (right) in Utah. Named for "ground-to-air pilotless aircraft," the 10-foot projectile is driven by aerojet units at supersonic speed. It has secret controls designed to track down enemy aircraft.

Saboteur Container. The receptacle below, attached to four parachutes, was used by Germans to drop saboteurs. Ten feet long, it weighs 490 pounds, has a nose of rubberized tubing to ease landings, and carries three men strapped in hammocks.

Radar engineer's idea, tried on dog, makes any tub a washer.

WASHING with SOUND WAVES

GEORGE E. ATKINS is a mechanical engineer in a New York research laboratory who worked on radar during the war. One day, a fellow worker told him about accidentally dropping an automobile horn in a pail of water. It had stirred the water like an egg beater on a bender. Mr. Atkins thought this over and decided to let noise do his wife's laundry.

After a year's work, he developed a tiny washing machine that creates sound waves with enough pressure to force the water right through every fiber of the clothes and push out the dirt. The machine weighs only 5½ pounds. It has a motor no bigger than a bar of soap. This makes a thin diaphragm vibrate and produce a sound like a vacuum cleaner. Placed in the water, it propagates pressure waves of such force and speed that a fine spray passes continuously through the clothes, reversing the old washing machine method of moving the clothes through the water. More than 12,000 waves per minute race through the clothes so quickly that each one is reflected back and forth several times before the next wave starts.

To test the gentleness and efficiency of the machine, Atkins put his dog in it. The poodle came out clean, happy and minus 12 fleas.

The operating unit, which is 10 inches long, consumes only 35 watts of electric power; rotary or paddle type washing machines use 200 watts or more. Six pounds of clothes placed in a six-gallon bucket of water can be washed in 10 minutes, with even lipstick and perspiration stains removed. The complete unit with a container for the family wash will sell for about $30.

The inventor plans to market a space-saving automatic washing machine especially suitable for apartment dwellers. Then the housewife will be able to turn on the switch, have a leisurely cup of coffee, and return to a washed, rinsed and dried laundry a quarter of an hour later.

The "vibramatic" unit weighs 5½ pounds and is designed to fit on the edge of a tub or basin.

As shown above, the shaft and diaphragm extend down into the water. The picture below reveals how 240 vibrations a second whip the soapy water into spray, forcing it through the dirty clothes.

The Constitution shelters a prewar eight-passenger transport under its 189-ft. wing.

FLYING DUPLEX

NAVY'S TWO-DECK TRANSPORT CARRIES 180 PERSONS, FLIES 6,000 MILES.

THE WORLD'S largest land-based transport plane, the Lockheed Constitution, big enough to carry 180 people or 35 tons of cargo 6,000 miles at top speed of 300 m.p.h., will take off on its first flight this month from the factory's field at Burbank, Calif. Designed to meet the Navy's need for a huge plane capable of reaching any island outpost with high-priority loads of men and equipment, the 92-ton Constitution is expected to be making one-stop flights from the West Coast to Japan and China within a year. It will find its way with the most complete navigational radar equipment ever installed in aircraft.

Now equipped with four 3,000-hp. Pratt & Whitney Wasp Major engines, the 156-foot airplane has characteristics that promise even more speed and power. Its high-altitude, high-speed, laminar-flow wing will permit the installation of gas turbines when they become available.

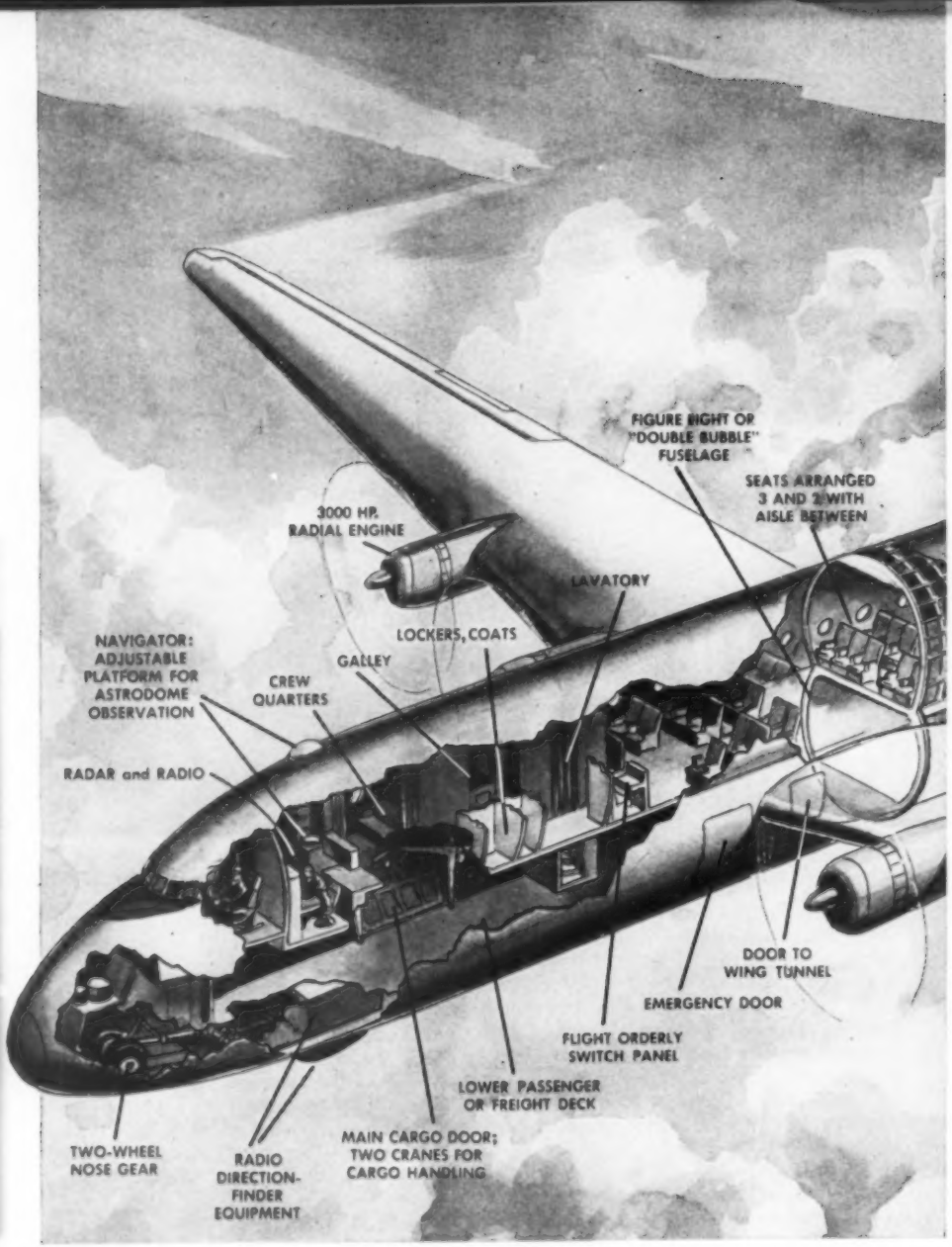
Within its figure-eight, "double bubble" fuselage, the Constitution can carry 92 passengers on an upper deck and 76 on a lower, in addition to a crew of 12. Spiral stairways fore and aft connect the decks.

The entire lower deck may be used for cargo. Hoists that can lift five tons at a crack will load and unload the plane at isolated bases through wide doors (106 by 74 inches) in the fuselage.

Two Constitutions have actually been built, at a total cost of $27,000,000. One will fly while the other undergoes extensive static tests to measure its full strength and potentialities accurately.

While it is estimated that the Constitution, because of its great weight, can operate from only 50 airstrips in the world, it can take off fully loaded in 2,350 feet, land over a 50-foot obstacle and grind to a stop in 2,300 feet. This equals the performance of many smaller transports. On small island fields, reversible inboard props will shorten the landing distance somewhat.

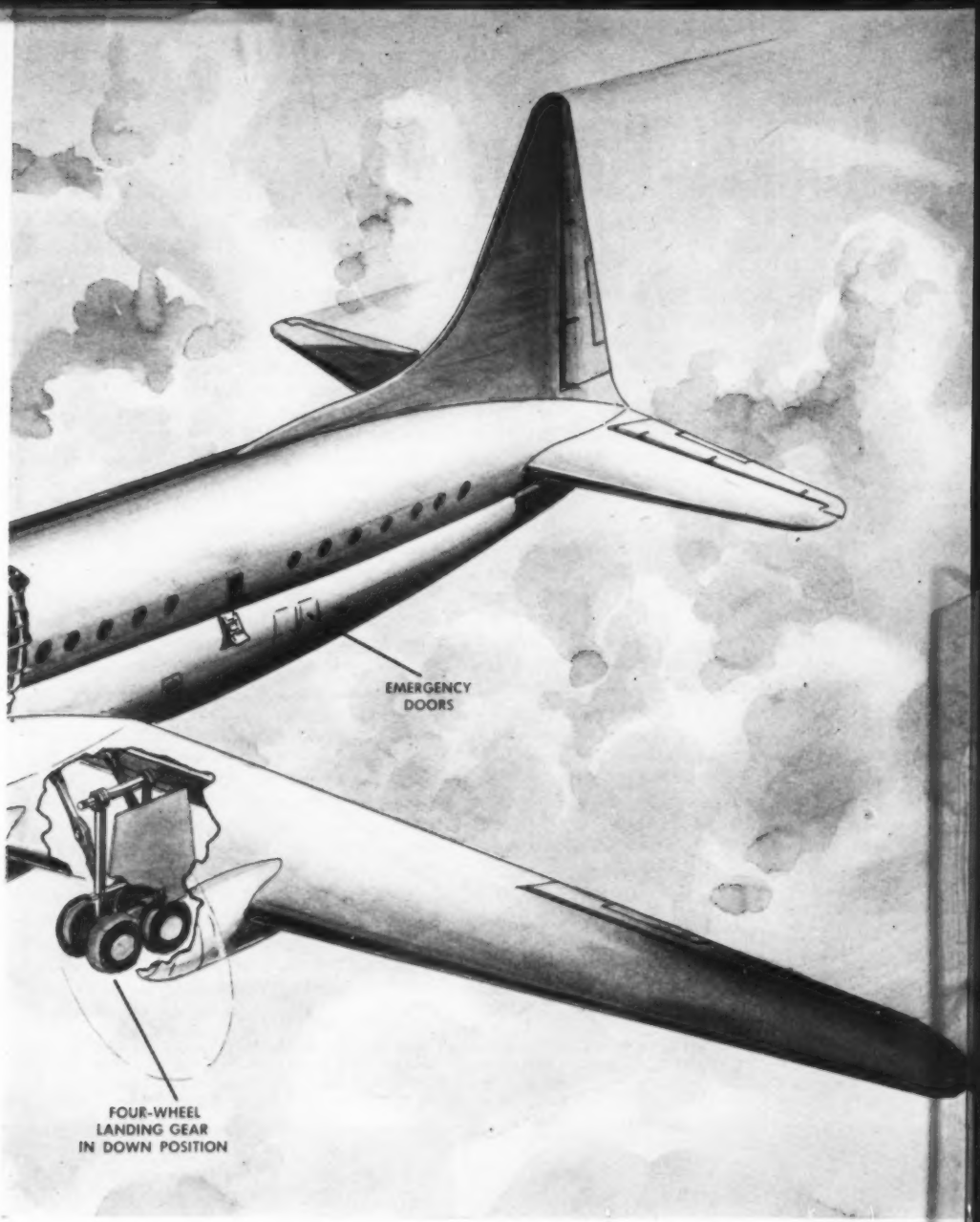
Four wheels on each main gear provide enough footprint area for landings on rough



tropical airstrips, and save a ton of structural weight. The plane also lands without the smoking impact usual with big planes: pre-rotation devices turn the wheels at landing speed just before they touch the earth.

For safety, the flight engineer will observe all propellers from his station through wide-angle lenses fitted into the side walls. He can reach all engines and most of the fittings through man-sized tunnels in the wing if he wants to make inspections or repairs in flight. A one-shot lubrication system makes it possible to pump oil to all four nacelles.

Air bled from the engine turbos and heated to 300 degrees F. keeps all leading edges warm enough to prevent the formation of ice, while electric wires imbedded in the windshields guarantee unobstructed views for the



pilots. Some of the edge-heating air (PSM, July '46, p. 112), moving through a pair of heat exchangers, warms the cabin.

Three hundred hot meals can be served aboard on long flights. Immersion heaters in tanks by the stairwell and under the wash basins in the rest room provide hot water for cooking, bathing and shaving. Garbage, stowed in tin cans, will be tossed overboard when the plane is flying at low altitudes over open ocean.

Enough gasoline to fly 6,000 miles—9,990 gallons—is carried in four integral wing tanks, sealed tight with putty made from crude rubber. So fueled, the Constitution can ferry important cargoes from New York to the Panama Canal in eight hours, to Dakar in West Africa in 13 hours.

Rocket Camera to Shoot Sun

V-2s will carry spectrograph outside filtering blanket of atmosphere.

By MARTIN MANN

THAT long-standing riddle—what makes the sun tick—may soon be solved. Photographs now being made 100 miles above the earth by a V-2 rocket camera are expected to record ultraviolet rays so short that they cannot penetrate the atmosphere. From them, scientists hope to learn more about the source of all our energy and many of our troubles.

If you ever listened to a European broadcast suddenly fade into a bedlam of static, you have heard one effect of the sun. Huge oceans of hot gases on the surface of the sun jam radio communications. They also affect the weather, but the relationship between these sunspots and disturbances in our atmosphere is not understood. Sunspots have been blamed for booms and busts in business. And if enough could be learned about solar energy, we might be freed from worry about coal, oil, or uranium.

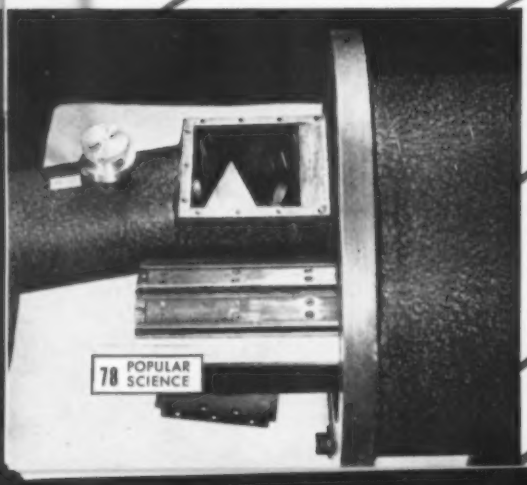
The few strips of film being exposed this year are not likely to clear up everything, but they are expected to show the first true pictures of the spectrum of the sun. And that may be the key—as new spectra frequently have been in the past—to discoveries of startling importance. The instrument made for this Navy-sponsored research, the spectrograph, is a prism placed inside a camera, between the lens and the film. The prism divides the light from the lens into its component wave lengths, or colors, so that the film records a broad spectrum band (the rainbow) composed of lines representing each wave length.

Since every substance has its own set of characteristic spectrum lines, which change with conditions, much information about the sun can be obtained from study of its spectrum record, or spectrogram. It is through such a study that the supervisors of the project, Drs. James S. Van Allen and John J. Hopfield, of Johns Hopkins University's Applied Physics Laboratory, hope to fill the existing gaps in our knowledge of the sun.

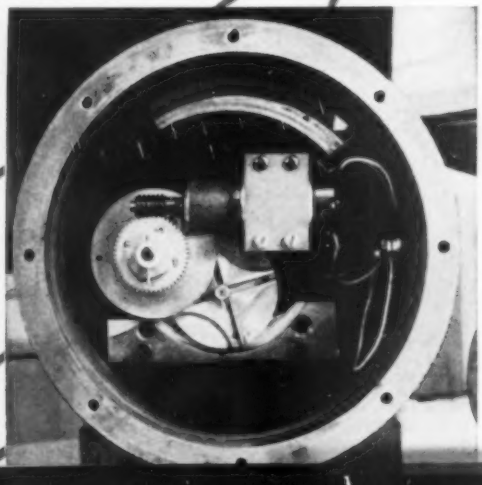
The V-2 spectrograph is expected to record light waves as short as 1,200 angstrom units (about 5 millionths of an inch). Only incomplete analyses of sunlight can be made on the ground, for the miles of air between the sun and the spectrograph lens filter out nearly all light below 3,000 angstroms. Previous attempts to climb above the filtering effect of the atmosphere by putting spectrographs in balloons, were not especially successful because the balloons did not rise more than 25 miles. Now the rocket can take a spectrograph up 100 miles.

A ride in a V-2, however, is not conditioned

The rotor that holds the spectrograph's film strips is slipped into its protective, lightproof shell. Inside the square opening is the lithium fluoride prism that separates sunlight into component colors.



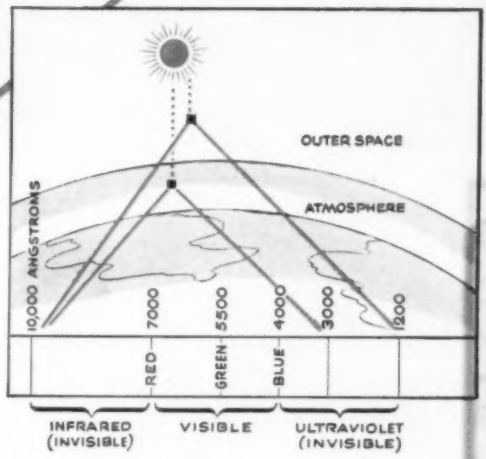
This gear and cam assembly moves the film-holding rotor so that a new strip of film is exposed every 20 seconds. The slotted cam wheel in the center of the photo is the heart of this intermittent movement.



Over-all view of the spectrograph. The ultraviolet light enters the instrument through the long tube, which is placed in the very nose of the rocket.

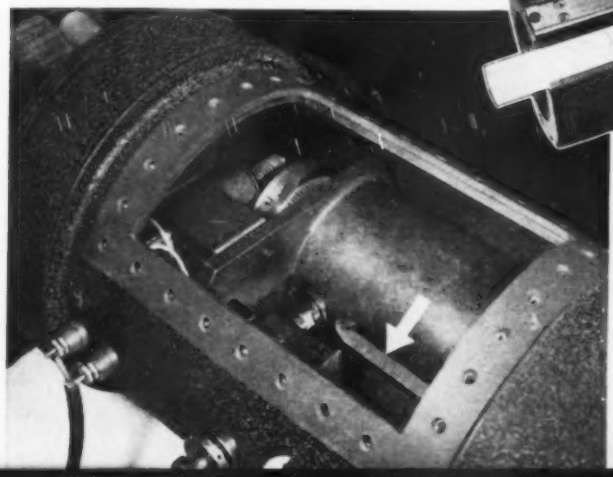
jaunt. The rocket smashes into the ground at about 3,600 m.p.h. with a deceleration rate equivalent to 20,000 times the force of gravity—at the instant of impact the tiny film strips, ordinarily weighing only a fraction of an ounce, reach an equivalent weight of 30 lbs. No spectrograph could be constructed to survive that crash. But a film holder might. Making the holder sturdy enough to protect the spectrogram in the final impact, therefore, became the major problem of the designers, John Forrest, Harold Straat, Ralph Dakin, and Walter Guenther of the Bausch and Lomb Optical Company, Rochester, N. Y. The result was a two-piece, cylindrical steel casket, called a cassette, that is practically indestructible.

The outer shell of the casket is an 11-inch hollow steel cylinder with a lengthwise



The atmosphere blocks sunrays shorter than 3,000 angstroms in wave length. The rocket camera, climbing above this filter of air, is expected to catch light never recorded before.

Through the opening in the spectrograph can be seen the cylinder that contains the film. The ultraviolet light enters this casket through the slot just below and to the right of center.



The solid steel film holder, shown above, is strong enough to survive the final 3,600-m.p.h. crash when the V-2 hits the earth with a force 20,000 times the pull of gravity. The 25-lb. cassette, containing the film holder, will then weigh half a million pounds.

Dr. John J. Hopfield, of Johns Hopkins, a supervisor of the rocket-camera project, fits the film holder into the spectrograph.

slot that admits the broad spectrum band. Into this shell fits the motor-driven film holder, a solid steel rotor with a number of flattened faces bearing guides to hold the strips of film. One portion of the cylindrical surface remains curved and is coated with black velvet. This curved section covers the slot in the shell before and after the film has been exposed, making a light-tight seal—like the slide in the film holder of an ordinary plate-back camera.

Acceleration a Hazard

The casket is fastened inside the body of the spectrograph, which is of simple design but extremely rugged construction. For even though the spectrograph may be destroyed in the final crash, it must withstand the terrific forces on the way up, when the rocket leaps to a speed of 3,000 m.p.h. within a few seconds. Lenses and prisms are made of synthetic lithium fluoride, which transmits ultraviolet light of wave lengths too short to pass through glass or even quartz. The objective lens, set in the tip of the rocket nose, is a hemisphere, giving an extremely wide angle through which light can be collected. With this unusually wide angle lens the spectrograph catches sunlight even though the rocket may not point directly at the sun.

To secure a number of spectrograms made at different altitudes, an electric motor turns the film-holding rotor, exposing a new strip of film every 20 seconds. This intermittent movement of the rotor is obtained with a cam wheel called a Geneva wheel, which acts somewhat like the mechanism in a motion picture camera.

As the rocket soars out of the atmosphere a microswitch, preset on the ground, starts the motor, bringing the first strip of film into position at the slot. When the last strip has been exposed and the black velvet again covers the slot, a bolt automatically locks the rotor and shell together.

Special film for use in the V-2 spectrograph was made by the Eastman Kodak Company. A fluorescent coating that glows visibly when struck by ultraviolet light helps record the very short wave lengths, since the gelatine in photographic emulsions does not transmit light below 2,000 angstroms.

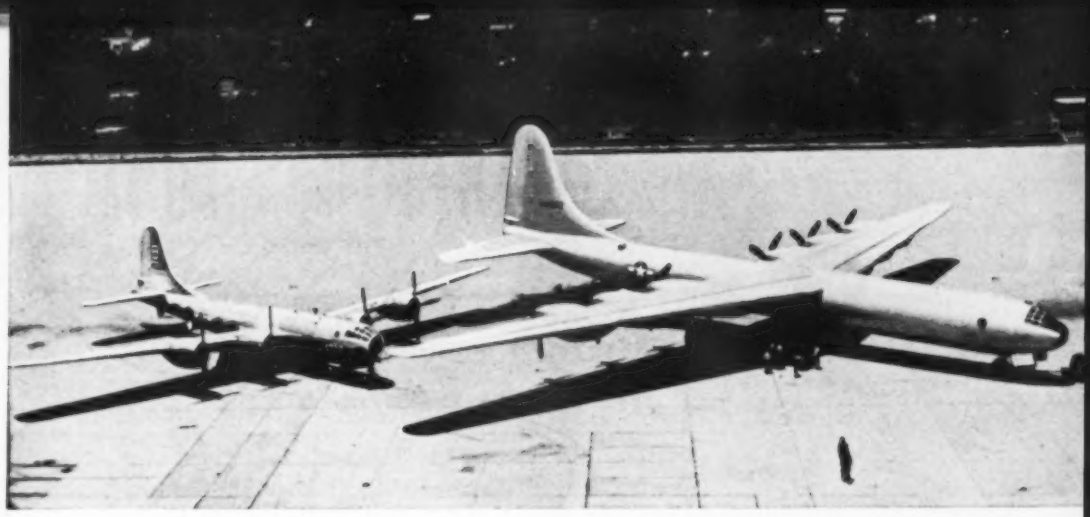
So far only one V-2 spectrograph has been built, future plans depending on the results obtained from the present experiments. If there is a second model, the designers plan to use a mirror, controlled by a photoelectric cell and moved by a servomotor, to reflect sunrays directly to the spectrograph.

Saving the Instruments

Modification of the rocket itself—to reduce the speed of fall and in that way minimize damage to component parts and instruments—has also been proposed. To save an instrument in the nose of the rocket, Dr. Hopfield suggests a time-fused explosive charge to blow away the head after the rocket reaches peak altitude. Tumbling end over end, the freed nose would drop more slowly than the rocket, which, stabilized by its fins, falls head first. Another method, also employing an explosive charge, would disconnect one fin, causing the entire rocket to tumble and fall more slowly. Attaching parachutes to the instruments, which would automatically be jettisoned after the highest altitude was reached, is another possibility.

Even these precautions may not work. The crashing rocket digs such a deep crater that recovery of any surviving instrument from the rubble of steel, earth and rocks can be very difficult. And if the hole fills with water, as one did, there would be small chance of fishing out a particular recording device.

Allowing parts of a rocket to fall separately also has its drawbacks. Too small for radar tracking, they could be lost forever in the vast desert. The record flight of the eighth V-2 is an example. Two weeks afterward, troops were still seeking records of the trip.

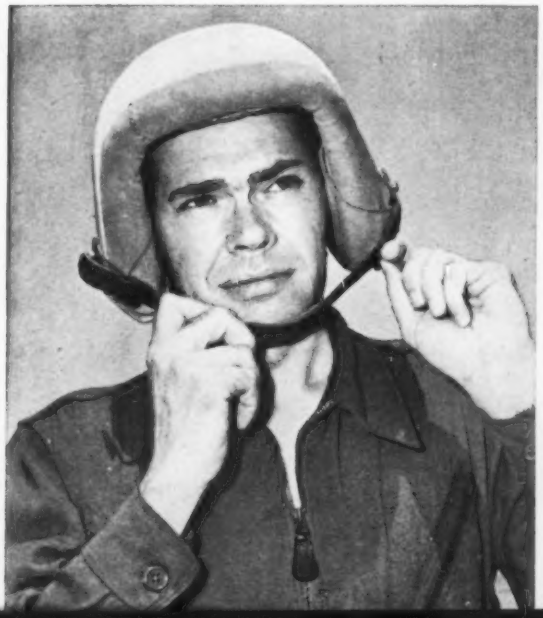


BIGGEST BOMBER. The Consolidated XB-36, world's largest land-based airplane, is shown above with a B-29 Superfortress, which used to be a monster in its own right. The war-born giant made its first test flight last August and, in the Army phrase, "exceeded expectations." So big that few present airports can handle it, the XB-36 is powered by six 3,000-hp. Pratt & Whitney pusher-type engines. It is 163 feet long, has a wing span of 230 feet and weighs 160 tons. Its tail is as tall as a five-story building, and its main tires are almost nine feet high. It is designed to carry a crew of 15 and 30 tons of bombs 10,000 miles. Consolidated has an AAF contract for a fleet of B-36s, and plans a 200-passenger air-line version.

WHAT'S NEW in AVIATION

GLASS HELMET. Made of laminated glass and styrene plastic, this bulging aviation helmet weighs less than two pounds. It has built-in radio headphones and a sponge-rubber interior for the wearer's comfort, and protects an airman's head by equalizing distribution of impact forces. Designed by the Aero Medical Laboratories, University of Southern California, and Northrop Aircraft, it was first used in tests of the XB-35 flying wing.

ROCKET BOMB'S FORERUNNER. Built to test the efficiency of flying-wing design for a rocket bomb, the midget man-carrying Northrop glider shown below is now used for instruction. With a wing span of less than 30 feet, the tiny craft is capable of slow rolls in free flight after being towed aloft.



WHAT'S NEW in AVIATION

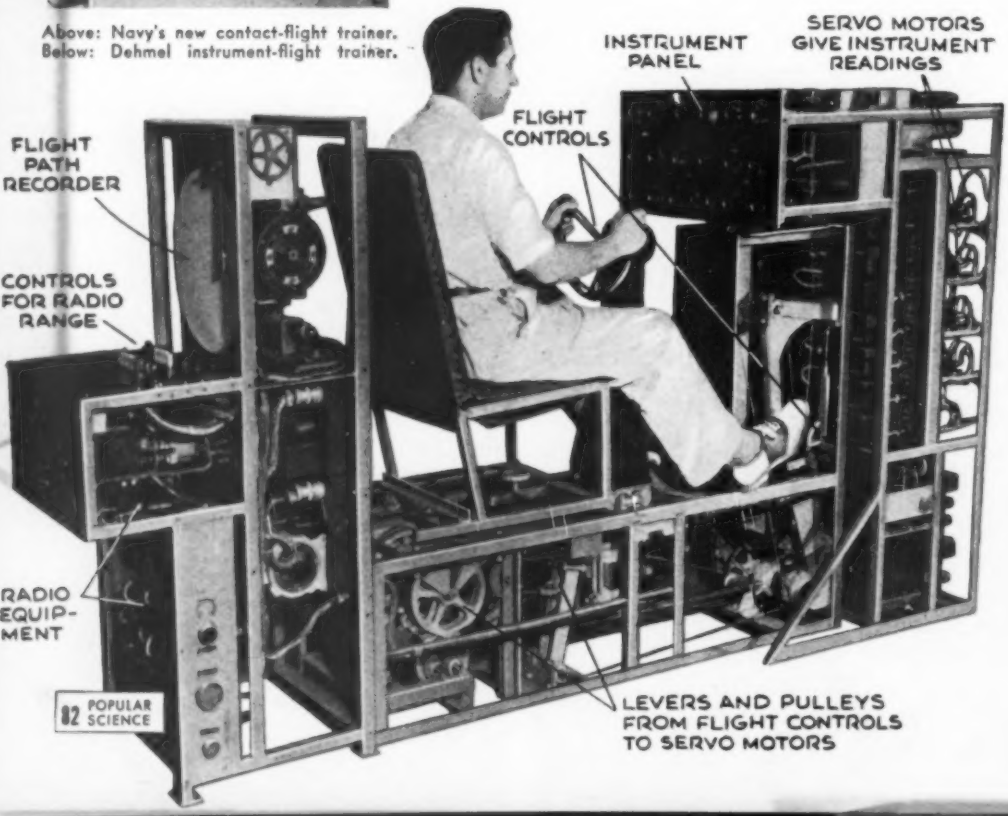
Machines to

New electronic trainers and tiny flight controls for switches make flying easier.

Above: Navy's new contact-flight trainer.
Below: Dehmel instrument-flight trainer.

PILOTS now can learn how to fly loops entirely by instrument in an earth-bound cockpit that doesn't budge an inch. The new electronic Dehmel flight trainer, produced by Curtiss-Wright, can imitate—on instruments—the flying characteristics of anything from a small personal plane to a four-engined transport.

In another recently developed electronic trainer, a cockpit on wheels equipped with a periscope, the Navy is teaching student pilots how to strafe, bomb, and launch rockets in an F6F. The pilot gazes through the periscope at a relief map on the ceiling and feels that he is looking at the earth from a moving plane. As he "dives," the periscope moves



Help Pilots

closer to the ceiling; as he "climbs," it retreats; when he "banks," its reflector cants realistically.

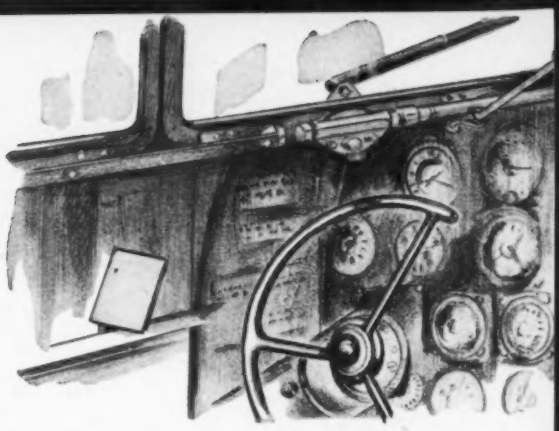
A third new mechanical aid for pilots, produced by the Douglas Aircraft Company, is a set of baby flight controls that are being used in place of switches in the cockpit of a still-secret jet plane. Psychologists say that the small-scale controls will simplify the highly demanding job of flying the plane, improve its pilot's reaction time.

As a student in the Dehmel instrument trainer goes through the motions of flying—flicking switches, moving levers—current dividers, called "contour potentiometers," send varying voltages to servomotors. The servos then change the instrument readings as they would change in actual flight.

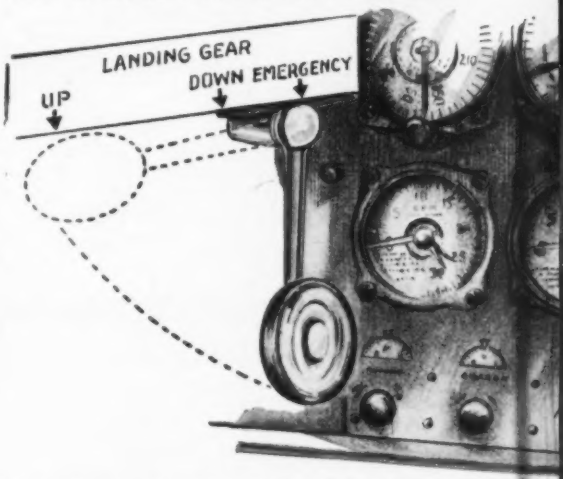
The radio system of this trainer is as complete as an air liner's. It can duplicate any radio range or airport beacon; it even imitates the CAA's blind-landing system.

The moving pencil of a flight-path recorder, mounted behind the trainer, tracks the "plane," enables the student to check his mistakes after each session. If a 360-degree turn is not constant, for example, the track will look like a badly warped egg instead of a perfect circle.

Recorded engine noises are piped into both the Dehmel and Navy trainers to help pilots learn to synchronize engines by ear.



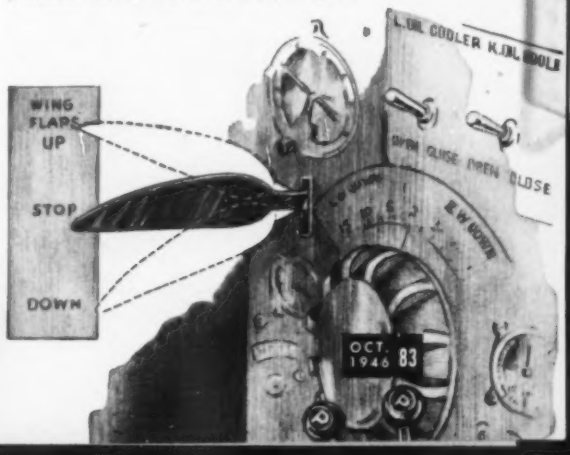
Among the Douglas toylike flight controls that enable a pilot to recognize and reach more quickly for the switch he wants is a small, hand-operated "foot" pedal for braking the jet plane's landing roll.

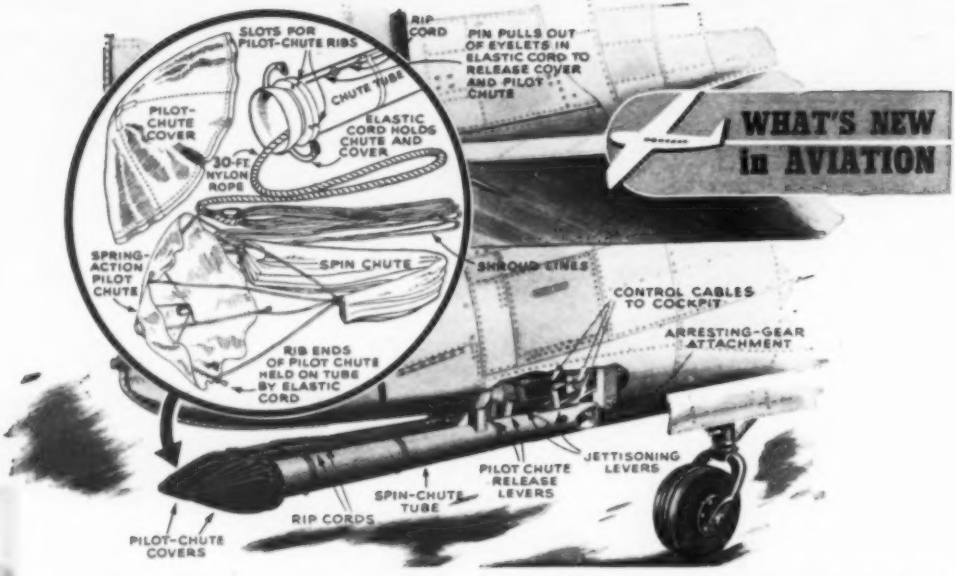


The landing-gear lever is a strut and wheel four inches long. Grouped functionally, the Douglas flight-control switches operate freely when the pilot is wearing his parachute and safety belt.

For a secret jet plane obviously intended to land on a carrier, Douglas engineers designed a miniature arresting hook in place of the switch the pilot normally flips to let his tail gear down.

The wing-flap lever, half an inch wide and three inches long, has a contour very similar to that of the actual flap. The movement of each small control parallels that of its full-size counterpart.



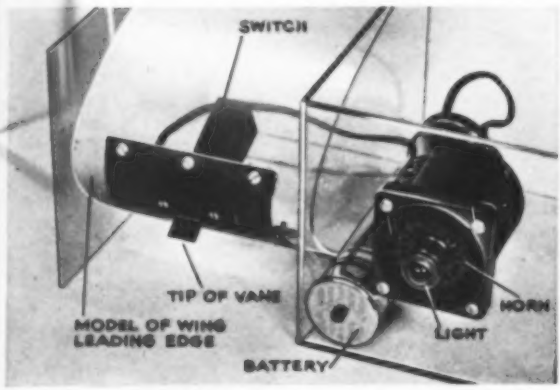


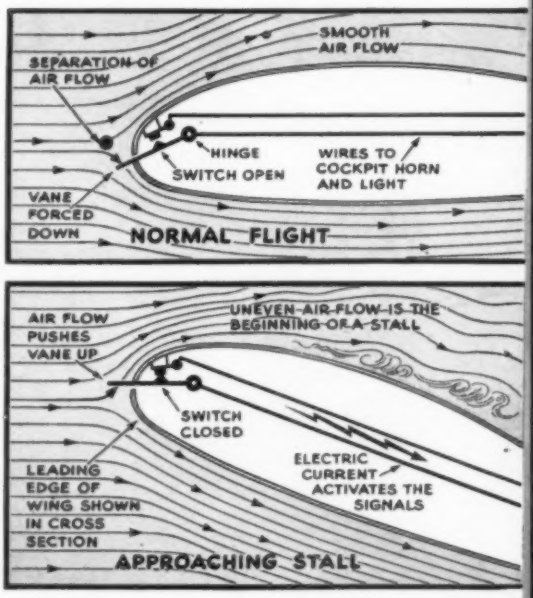
Parachutes for a Test Plane

SPIN tests on untried airplanes have always been perilous. When Martin prepared recently to spin-test its new BTM Mauler it went all out to provide safety for the test fliers and the costly prototype. It had two special spin parachutes designed. Each was tested for 9,000 pounds. These were placed in tubes under the fuselage (above). Had the Mauler gone into an unbreakable spin—which it didn't—the pilot could have saved himself and plane by releasing the 'chutes and checking the fall.

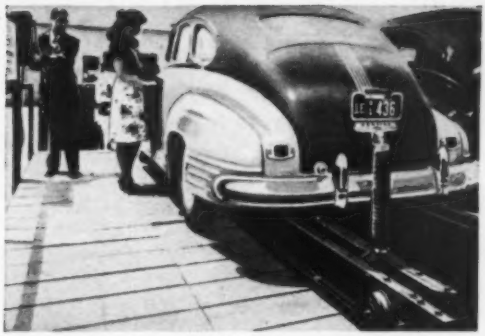
Red Light on Stalls

CAA RECORDS ascribe more than half of the deaths in private flying to the pilots' failure to recognize an approaching stall. Hope for reducing the rate of such fatalities lies in the Safety Flight Company's new "Stall Warning Indicator." This CAA-approved device (below) is mounted on the leading edge of a plane's wing (see diagrams) and when the stall point nears it flashes a light and sounds a horn in the cockpit to alert the negligent flier.





Push-button Parking

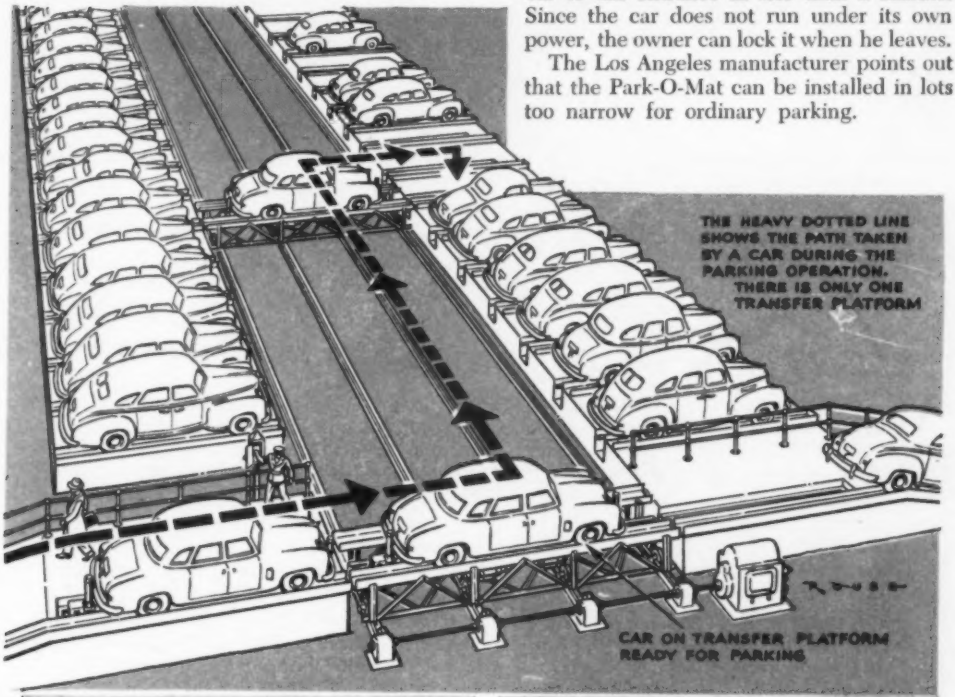


Owner locks car on leaving it. Attendant presses button, arm in foreground grips bumper.

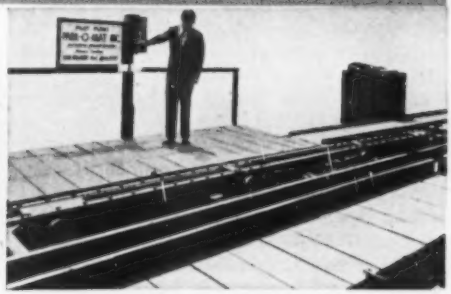
PRESS a button and park your car! The Park-O-Mat automatically places an auto in any desired stall of a garage. With it, more cars can be parked in less space in less time by fewer attendants.

At the garage entrance arms grip the front and rear bumpers and slide the car to an elevator. This stops at the proper floor; arms slide the car into the stall. Another button reverses the process, bringing the car to the entrance in less than a minute. Since the car does not run under its own power, the owner can lock it when he leaves.

The Los Angeles manufacturer points out that the Park-O-Mat can be installed in lots too narrow for ordinary parking.



Arms automatically roll car onto the transfer table, which will carry it to empty stall.



After leaving car, positioning device returns to entrance where operator stands at controls.

The Weirdest DANGER in the WORLD

Eternal vigilance is the price of handling radiation safely.

Only distance protects against radiation, such as scarred this Japanese boy.

By CARL DREHER

YOU visit your dentist and he thinks there may be something wrong with that bicuspid—better take a picture. He puts the X-ray film carefully into place and then he tells *you* to hold it there. It is the one operation he cannot perform for you. The rays from his low-power machine, harmless to patients who undergo them only at long intervals, would add up, and sooner or later he would lose his fingers—or worse.

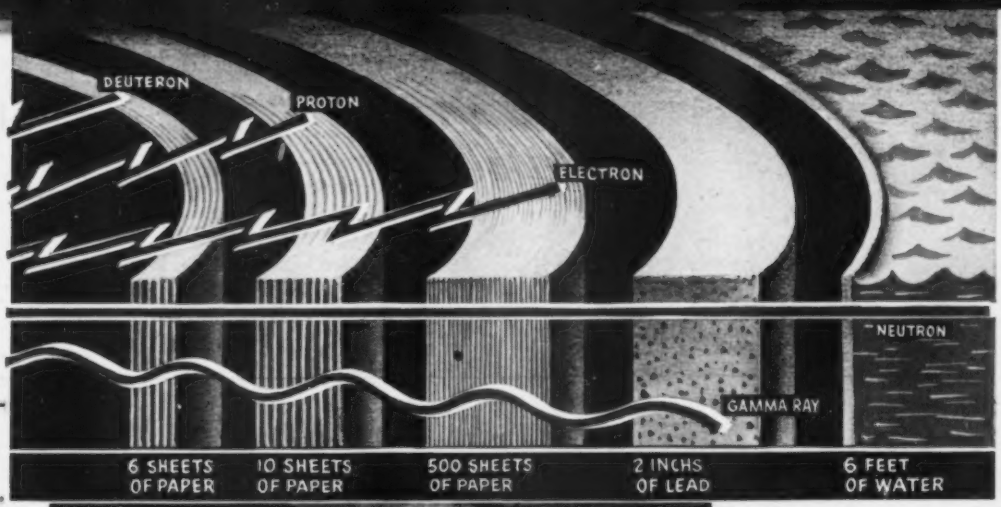
Before 1895, when Roentgen discovered the X-ray, sunburn was the only harm done to people by radiation. But now atomic bombs have released vast invisible clouds of lethal radioactivity, and lesser but dangerous amounts of radioactivity will become commonplace as atomic energy is put to work.

For protection against this, the weirdest danger in the world, men must depend entirely on advance precautions. One can get a fatal dose, either cumulatively over years or in a millionth of a second, and not know anything has happened to him until too late. Man's inventiveness, in short, has far outrun his built-in safety equipment—except for the protection provided by his brain.

Radiation as such is nothing to be afraid of. The eye sees by electromagnetic radiation. Solar radiation warms and feeds us. Radio waves pass through our bodies and we never know it. Even the centimeter waves of radar are so long, compared to the cells and atoms of the body, that they cannot harm us.

It is artificial radiators which emit subatomic particles or waves that cause trouble. These include naturally radioactive substances like radium that become dangerous—and useful—when concentrated from ores, and man-made isotopes of familiar elements. Another category includes X-ray generators and all the various atom-bombarding and fissioning devices like the cyclotron, the uranium pile and the atom bomb. Finally, we must reckon with everything that has been rendered radioactive by exposure to such devices.

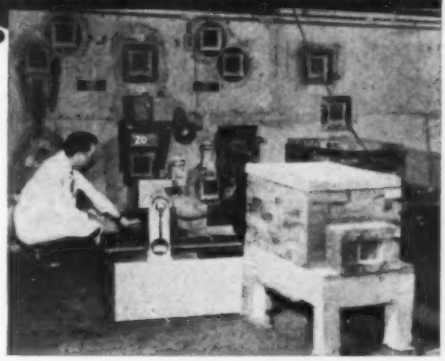
The danger however, can be measured. The unit of X-radiation is the roentgen (r), and the human body should not be subjected to more than 0.1 r a day as a regular



Drawing above shows what it takes to stop various atomic particles and rays.

In removing radioactive material from pile after neutron bombardment (left), carrier block is pulled into lead shield to protect workers. Meanwhile, pile halts. Below, defined radiation beam, issuing from hole (No. 20) in shield of atomic pile, is halted by lead bricks in foreground after passing experimental device in center.

WORKING WITH RADIOACTIVE MATERIAL FROM ATOMIC PILE, OAK RIDGE, TENN.



thing. This tolerance dose allows a sizable safety margin but it is better not to experiment with an overdose.

Measurement reveals the danger. Protection may be secured in three ways: distance, direction and shielding.

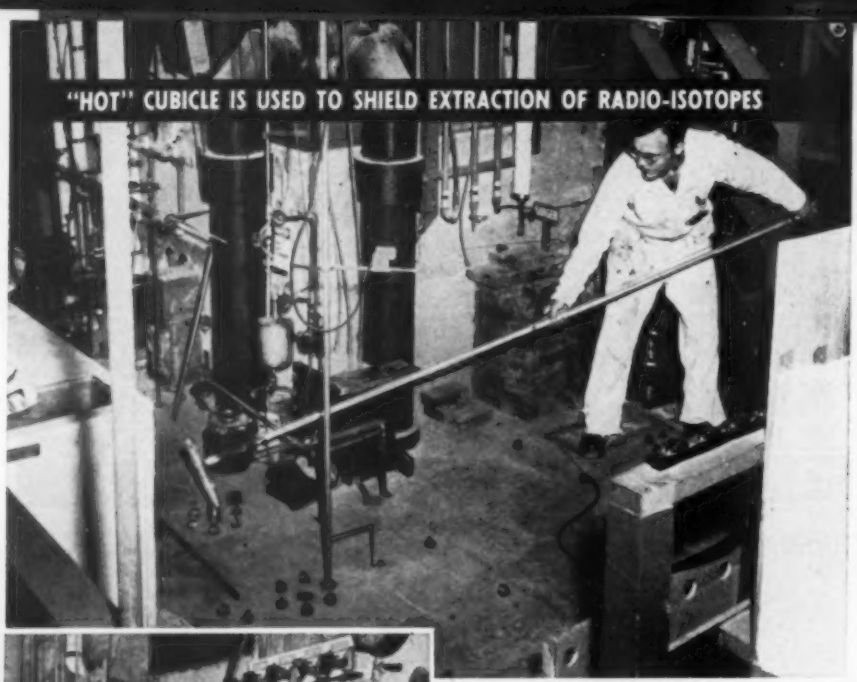
Distance is effective since intensity normally falls off according to the inverse square law—double the distance from the source and you get only one-fourth the intensity. Radiation sources should, therefore, be as far as possible from occupied rooms in the same building.

Directive protection depends on beaming the radiation. Precautions must still be taken against the scattering of the beam when it strikes an obstacle, such as a patient—or even air.

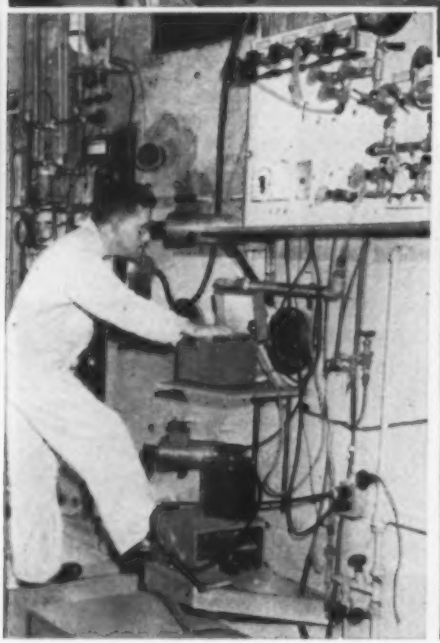
Shielding consists of interposing materials between the equipment and the operators. Additional partial protection is given by rubber-lead aprons and gloves. Shielding may also be built into the radiator itself, as in the modern X-ray tube.

Despite these safeguards, operators and innocent bystanders are going to absorb some radiation. No important source is

"HOT" CUBICLE IS USED TO SHIELD EXTRACTION OF RADIO-ISOTOPES



Long-handled tongs keep physicist at safe distance as he puts highly radioactive material into "hot" cubicle, where it will drop down to processing units.



Periscope is used for safe observation of separation of fission elements from pile uranium, taking place in cubicle behind two-foot concrete wall.

Workers wear film badge and pencil-like radiation meters on shirt to record personal exposure as they test apparatus in cubicle that is not in use.

weak enough to be wholly harmless. The New York City Board of Health recently banned baby X-ray outfits used in fitting shoes.

In practice, a powerful source with built-in protection is likely to be safer than a weak one where safety depends upon skillful use. A dental X-ray operator will receive his daily dose of 0.1 r in eight mouth examinations—even if he keeps out of the beam. If he doesn't, he will get more than the tolerance dose. Fluoroscopic units, where

the picture is thrown directly on a screen, can also be dangerous. The operator is liable to turn up the current to get a brighter image, and overexpose himself. Mobile X-ray equipment in hospitals and factories likewise requires fast work and, sometimes, rotation of operators.

X-ray penetration varies with the tube voltage. The higher the voltage, the more necessary—and more difficult—it is to confine the radiation by fixed shielding. Present-day medical and industrial machines range from 10,000 to 2,000,000 volts. Lead is an effective barrier at low and moderate voltages. The entire room must be covered except for the lead-glass observation window, sometimes backed by water or a lead solution. Dangerous radiation may escape through the smallest leaks, so nails must have lead-covered heads and sheeting must be overlapped at the joints.

Lead is easy to work, but expensive when, for example, a half-inch thickness is required to reduce the radiation from a 400,000-volt X-ray unit to the tolerance level at 13 feet. Consequently, at the higher voltages, building materials are generally used, although sometimes 20 times the ordinary thickness is required. Concrete becomes more effective, however, as the voltage goes up: at 1,000,000 volts the ratio is little over six to one.

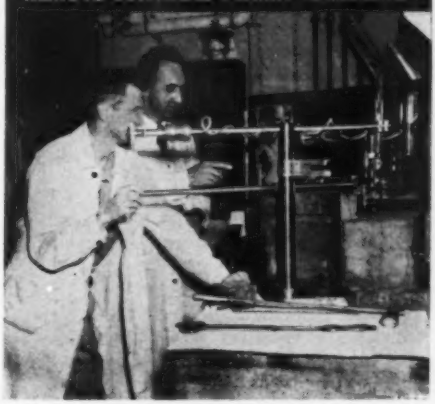
The 1,000,000-volt X-ray installation at Memorial Hospital in New York has concrete walls 15 to 36 inches thick, a 36-inch floor and an 18-inch ceiling. The lead-covered door is additionally protected by a 15-inch baffle wall. This room is well-shielded; at no point outside is the radiation greater than 1/10 of the accepted maximum, and at the operator's control station, behind a water tank and window of leaded glass, it is only 1/25.

A million volts are often used in industrial work, sometimes without adequate protection. With a large industrial machine on full power and nothing in front of the tube, the radiation at 100 feet may greatly exceed the tolerance level. It may pass through the building wall and expose people outside or even in another building. To add to the danger, typical targets of a high-voltage industrial unit, such as armor plate, require long exposures. The beam is best directed toward the ground.

In the betatron the electrons are whirled through thousands of revolutions and then loosed at the target like a stone from a sling. Sharply beamed, the betatron is not yet a radiation headache, since the few in existence are in highly skilled hands. But Dr. G. Failla, one of our foremost radiologists, recommends that the safety limit for betatron workers be reduced fivefold to 0.02 r per day.

Shielding a cyclotron is another problem entirely. The neutrons it emits behave differently from X-rays and lead and concrete are less effective shields. In lead, the neutrons bounce off the heavier nuclei and continue on through the atom. Neutrons will,

REMOTE CONTROLS PERMIT HANDLING



With this remote manipulative device, workers can open bottle of radioactive material and draw a sample while staying outside danger zone. Bottle is buried in heavy lead block with only top sticking out. Mirror shows what's happening behind shield.

Lead-brick wall guards physicist as he evaporates a purified sample of a radio-isotope in "semihot" lab. Long tongs are used to handle beaker.

however, give up most of their energy to a hydrogen nucleus, which weighs almost exactly the same. The action is like that of two billiard balls. Paraffin, sawdust, and water, all hydrogen-rich, are most effective.

The 60-inch Berkeley cyclotron is almost enclosed by five-foot water tanks, and the operators stay behind an 18-inch concrete wall. Since the cyclotron gives off other radiations beside neutrons, lead is also used. Water tanks 25 feet thick may shield the new 184-inch cyclotron which will be isolated on a lonely hill, the control room probably behind 100 feet of earth.

The atomic power plants are shielded mainly by "very thick" walls of concrete with steel doors. All operations are handled by remote control. The principal radiation from an atomic pile is neutronic, but alpha and beta particles and gamma rays are also present. The splendid safety record of the Manhattan Project shows what can be done in protecting personnel.

But accidents will happen. Even at safety-conscious Massachusetts General Hospital, six qualified experts received doses of 1,000 to 2,000 r during a few seconds exposure last year while testing a 1,200-kilovolt electrostatic generator. This machine emitted an electron beam that the men carefully avoided, but collision with air particles scattered enough electrons to produce severe burns. And at Los Alamos, Dr. Louis Slotin, a well-known atomic scientist, was killed recently when enough fissionable material was accidentally brought together to cause a flash of gamma rays and neutrons. Slotin knocked the equipment apart after the fatal slip occurred and seven other workers survived.

If radiation is released for military purposes, the possibility of protection is dubious indeed. Bikini taught us that the sole protection from radiation when an atomic bomb explodes is distance and plenty of it. The flash of lethal radiation, principally gamma rays and neutrons, lasts only a millionth of a second, but it is likely to finish everyone within range, even if they survive temporarily. At the same time, fission products are flung in all directions.

Uranium fission products include isotopes of strontium, zirconium, tellurium, molybdenum, and ruthenium. Where these are deposited the area will remain radioactive from 32 days to five years. The same applies to large masses of water or steel ("hot" ships or buildings) in which radioactivity may have been induced. Moreover, poisonous particles may be inhaled and fish caught in radioactive water may be deadly.

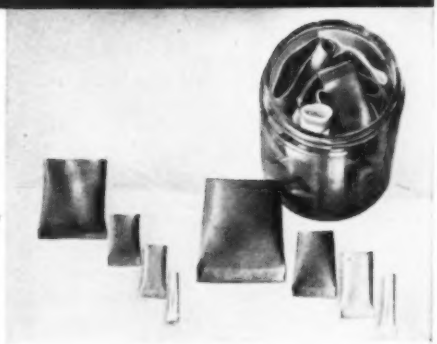
The only safeguard for atomic-bomb radiation is political rather than technological. But for peaceful uses radiation can be controlled like any force of nature. Unquestionably atomic power has sharply increased the risks—but also the blessings, actual and potential. If nobody was endangered by radiation 50 years ago, neither could anyone detect a flaw in a steel rail nor have a thyroid cancer treated with radio-iodine. For better or worse we are living in the atomic age, which is also the age of radiation. What we make of it is up to us.

CONSTANT CHECK PREVENTS LEAKS, GUARDS WORKERS AGAINST CONTAMINATION

Dangerously radioactive materials are moved from lab to lab in special lead containers. A probe counter, at right, checks possible radiation leaks.

All lab workers undergo frequent checks for possible radioactive contamination. They wear washable clothing and special shoes marked by painted toes.

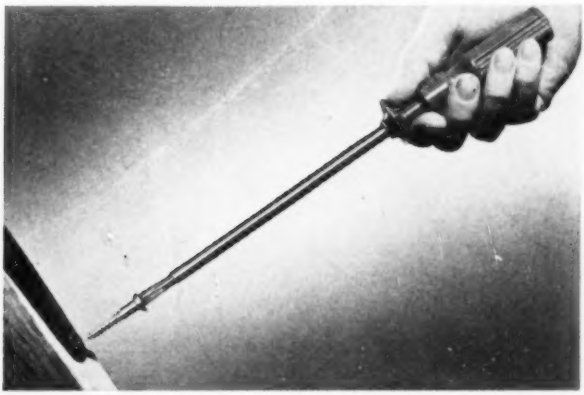
PLASTIC NEWS



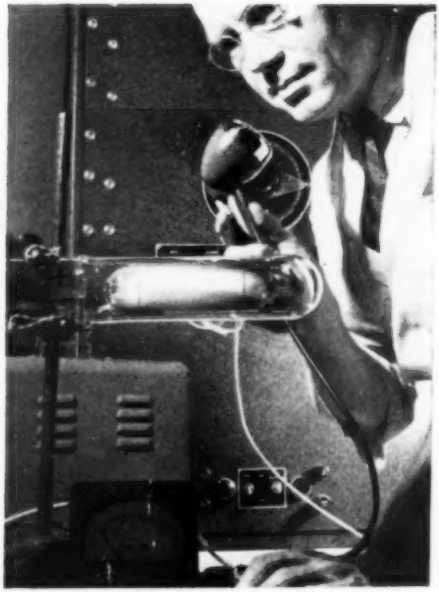
CAPS AND SLEEVES FOR TOOLS. A tough protective coating can be applied to tools, machine parts, tubing or wires with a new process developed by the chemical department of General Electric. Plastic material, available in caps or sleeves, is immersed for two to four hours in a dilating solution that expands the material as much as 50 percent. Then the sleeve is put in position and allowed to dry, which shrinks it to less than original size. As an insulating grip for wrenches and pliers (above, left) the material also protects the tools from rust or corrosion. Fitted over a threaded part (upper right), it shields the threads from damage. The sleeves (lower right) are shipped dry and tests have indicated that the coating will keep indefinitely without splitting and cracking.

LIGHTWEIGHT MICROPHONE. Tenite plastic, a cellulose acetate butyrate product, encases a crystal microphone designed as a hand or table model for home recordings and public-address systems.

SCREW-HOLDING SCREWDRIVER. The double blade of the screwdriver shown below can be separated inside a screw head to hold it for setting. Handle and button that operate blade are Tenite.

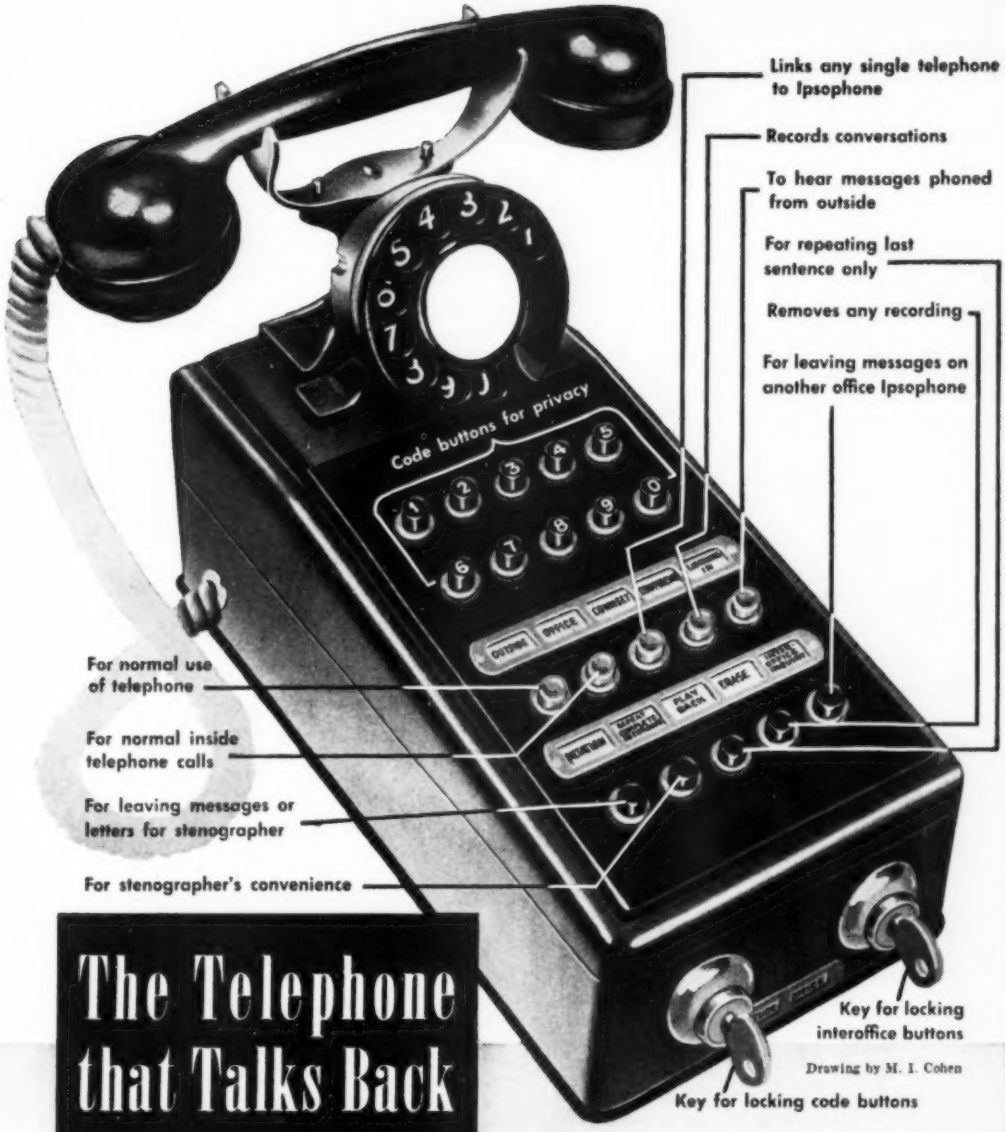


Camera Transit. A combination camera and surveyor's transit, made by Fairchild, eliminates a lot of field work, slashes survey costs. The aluminum-alloy camera has an 8¼-inch f6.8 Goerz Aerotar lens and Wollensak #4 shutter.



Lamp that Talks. The gap between radar and walkie-talkie has been bridged by Westinghouse's new cesium-vapor "talking lamp." The lamp picks up words from a mike (above) and transmits them secretly by infrared rays to a parabolic reflector. This receiver unscrambles the rays and reconverts them into clearly audible words at conversational speed.

Ever-Clear Windshields. Nesa, a new method in which glass gets a transparent coat which can carry electric current to all parts of a windshield, spells an end to icing and fogging (below, right). Pittsburgh Glass developed it.



Drawing by M. I. Cohen

The Telephone that Talks Back

THIS is the versatile Ipsophone. It will automatically answer the telephone, tell the caller to "go ahead," and then record his conversation. The instrument, complex in design but based on a simple principle, combines a telephone and a steel-wire recorder. It can be hooked up to any telephone line.

An amazing feature of Ipsophone is that it will divulge recorded messages over the telephone if given a prearranged code number. To get this service, the user opens the lock on the left at the bottom of the receiver box, punches the desired code number on the top two rows of numbered buttons, and relocks the lock again for secrecy. In calling the robot to ask for messages recorded during an absence, the user says "Hello" twice in a distinct voice and gives the secret code number. The "telephonograph" then repeats its stored conversation, erasing it afterward if told to. Werkzeugmaschinenfabrik Oerlikon, a Swiss firm, developed the Ipsophone. It is not yet available in the United States.

"Casing" Clouds for Safer Flying

Its bulbous nose covering removed, a P-61's search radar is adjusted for the next flight through a thunderhead. This radar pictured the rain core of each approaching cumulus on its scope.

Thunderheads explored by planes, gliders and radar in Florida skies.

By WESLEY S. GRISWOLD

PSM photos by HUBERT LUCKETT

HANDMADE "thermal sniffers," which can scent a rising current of warm air four seconds ahead of a glider's wing and guide the pilot to it, nosed through storm clouds over central Florida last summer, hunting for information vital to everybody who flies. The "sniffers" rode rough skies as part of an all-out effort by the AAF and Weather Bureau to find out exactly what goes on inside a thunderhead. Rugged P-61s joined the search, carrying precision-made meteorological and aircraft instruments, VHF radio, radar, movie and aerial cameras into ice, snow, and hail miles above the baking earth.

Safe flying in the dirtiest weather will come sooner because of this clinical study of storms, which went on from June 28 to September 30 in and over a perspiring sector about 20 miles southeast of Orlando and will be resumed next April in Ohio.

The doctors who took the pulse, listened to the breathing, checked the blood pressure, and photographed the insides of sullen thunderheads were mostly volunteers. In addition to the P-61 pilots they included glider pilots of the Soaring Society of America, Weather Bureau technicians, instrument experts from the National Advisory Committee for Aeronautics, and University of Chicago scientists. By April the Navy expects to join the probe with its Hellcat drones, engaged this year at Bikini.

A diamond-shaped area of some 60 square miles was roughly staked off in the scrub pines, swamps, and sand around St. Cloud, and dotted with every available weather instrument that would be useful. With far-sighted radar, ground-based west of Orlando, developing storms were spotted and tracked. When it became certain that the mushrooming cumuli would pass through the open-air consulting room prepared for them, the P-61s were sent up from the oven-hot runways of Pine Castle Army Air Base to batter their way through the churning cloud masses.

Instruments in the planes automatically

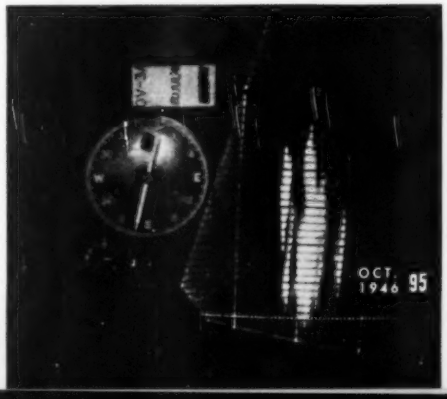
recorded the buffeting turbulence, mile-a-minute updrafts, temperature ranges, pressures, and relative humidity they encountered at 200 m.p.h. Gliders were towed into position to rise into the thunderclouds on wind-current elevators and make similar recordings at a more leisurely pace. Self-operated movie cameras filmed the brief life stories of storms, took thousands of pictures of radar scopes and instrument dials.

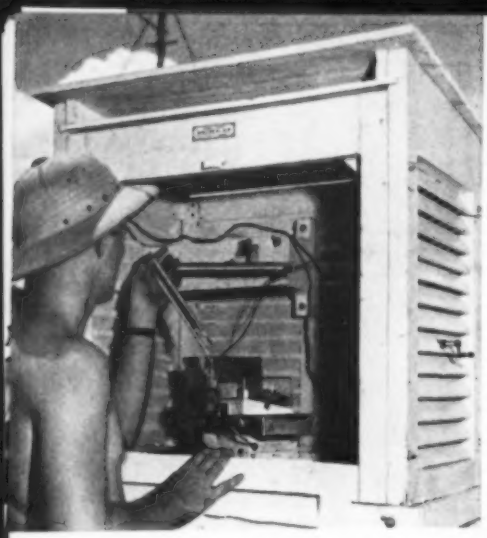
Nobody knows yet precisely what causes a thunderstorm and what happens in its boiling interior. There is no way of telling bad clouds from worse. But when the miles of movies and graphs made in Florida and scheduled to be made in Ohio have been analyzed, man will know much more about the kinds of planes, instruments, and techniques he needs in order to fly safely through the most dangerous atmospheric conditions.

Two-man training gliders, lent by the Navy, were loaded for thunderstorm probing with instruments they had never carried before. In the co-pilot's place were an eight-channel VHF radio, recording cameras, and a barograph. Each instrument panel had 11 dials instead of the usual six.

Revolving radar antennas (left) at Orlovista swept the horizon for developing clouds. Controllers watched thunderheads grow on their scopes (below), tracked P-61s to the edge of a designated storm, often 20-30 miles away; "talked" them through it by radio.

Rocking steadily as it gaped at the sky, "Beavertail" (left), a height-finding radar at Orlovista, measured distant cumuli from base to tip on a scale graduated to 40,000 feet. The cloud photographed on the scope below towered about 25,000 feet.



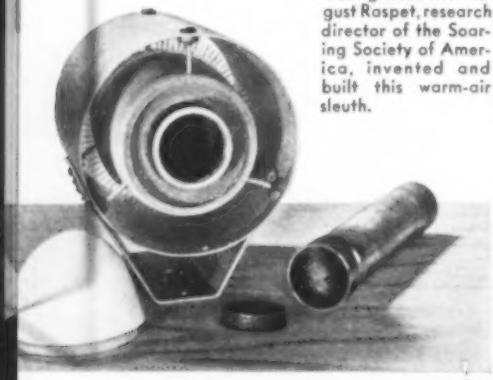


There were 55 of these Weather Bureau huts scattered at one-mile intervals over the test area. When a thunderstorm crossed this sector their instruments automatically recorded all changes in pressure, temperature, humidity, and wind that took place beneath it.

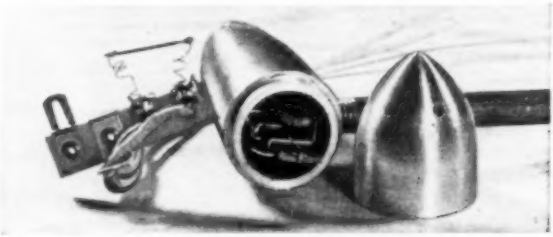
Sending a radiosonde balloon aloft near Lake St. Cloud to "get a picture" of the upper air before the day's convection started. Convection is the building up of turbulence without necessarily producing clouds. Radio direction finders tracked the balloons.

A "thermal sniffer" (below), used for the first time on the thunderstorm project in Florida, is a ring of 100 delicate thermocouples girdling a fat balsa-wood container with a core of ice and water in a metal cylinder. Circular aluminum shield protects the thermocouples from the sun.

Two "sniffers" were mounted 50 feet apart on the wing tips of a glider. A string galvanometer in the cockpit measured the temperature gradient between them, recorded changes as minute as 1/250 of a degree Centigrade. Dr. August Raspet, research director of the Soaring Society of America, invented and built this warm-air sleuth.



A sensitive free-air temperature gauge with a time lag of only one second, the thermoresistor or "thermistor" (below) was improvised in Florida by overworked NACA and Univ. of Chicago instrument experts. Nicknamed "salt-and-pepper shaker," the thermistor was mounted above the hood of each P-61. Baffles in its nose kept rain from soaking the resistor (at left, outside its aluminum housing), a needle of carbon material. When a low current was passed through the resistor its resistance varied greatly with even a slight change in temperature. The current was amplified and a cockpit dial recorded the temperature change.



PIN-UP

BEECHCRAFT BONANZA. The butterfly tail, replacing rudder and stabilizers, is introduced into the civilian plane field with this new, all-metal, four-seater. A six-cylinder, air-cooled, pancake engine, geared to an adjustable propeller, gives a cruising speed of 175 m.p.h. Price: $7,345, f.o.b., Wichita, Kans.

ODD JOBS for ODD HOURS

The 50-foot throwback to prehistoric times shown above is one of the inflated rubber monsters that Ed S. Conner, of the Goodyear Tire and Rubber Co., dreams up in his spare time. When they are not charging hunters for the benefit of a photographer, the novel products of Conner's imagination are rented or sold to enliven parades or play a part in advertising stunts.

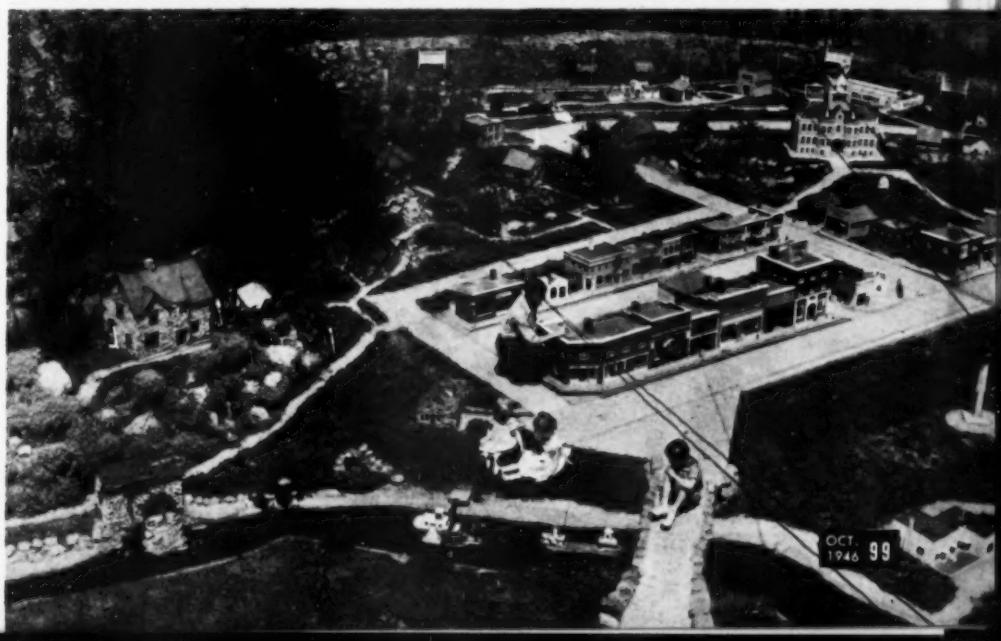
Photos from a film produced by JERRY FAIRBANKS

Working with an acetylene torch and molten metal instead of the chisel and stone that most sculptors use, Floyd F. Nichols (right), David City, Neb., creates miniature works of art from steel welding rods. He studied anatomy before he took up his unusual art medium, and now puts his knowledge to use in his hobby. He specializes in the portrayal of horses and men in action.

There are fewer crowned heads than there used to be, but many of the crowns worn by past and present royalty have been recreated by Max Berman (above), Santa Monica, Calif., a retired jeweler, in his collection of synthetic reproductions. He is shown putting the finishing touches to one of his copies. Among his collection are reproductions of the crowns of Nicholas II of Russia, Napoleon, early English kings and many others, as well as scepters and swords. Motion picture studios rent his glittering imitations for court scenes.

Making scale-model miniatures of firearms and ammunition is the pastime of Carlos Diniz, Beverly Hills, Calif. His collection is shown above, with its proportions emphasized by the bulk of the normal-sized weapons in the background. Items in the collection range from pistols to machine guns, and represent developments covering several hundred years—from wheel locks of the 16th century to weapons employed in World War II. Some of his tiny creations, especially the pistols, are scarcely larger than a match, but he fashions every part exactly to scale. Seated at his workbench (at left), Diniz examines his model of a present-day automatic rifle, which is not much bigger than an ordinary lead pencil.

"Littletown," a miniature village built of odds and ends, was begun 11 years ago by William Murray, Chesterton, Ind. It is a complete town, even to the ships sailing its waterway for the enjoyment of young onlookers, and includes a hotel in addition to its houses, shops and public buildings.



Printing Color through a Bull's-Eye

Variscope replaces filters and makes truer pictures.

By E. J. MURRAY

REPRODUCING photographs in natural color, long a difficult and uncertain process, can now be done with great accuracy and without the use of cumbersome multiple filters. The new Variscope does the trick.

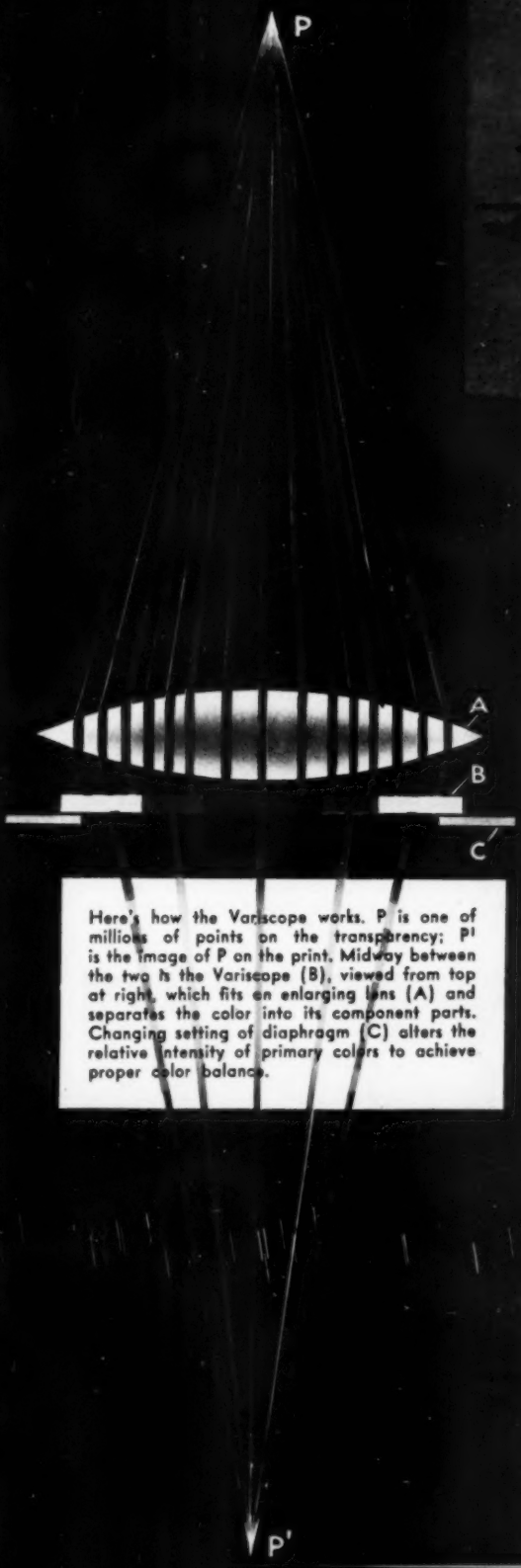
Developed and perfected by C. H. Birch-Field, of New York City, and his son, Arthur, the same team that invented the Iriscope (for making color projections from black and white stills), the Variscope looks like a small transparent bull's-eye. It is a disk made up of three concentric rings of color, mounted in a fixture that roughly resembles the iris of a camera lens. When attached to optical equipment, it can be adjusted with a twist of the fingers to control and modify color balance in transmitting photographic images from a transparency to a reflecting surface, such as printing paper or a plain wall screen.

This apparent simplicity is deceptive so

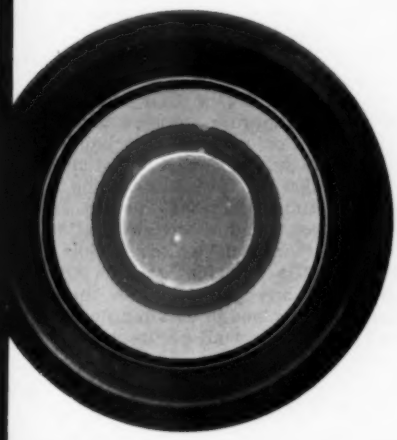
The three color photographs on this page are all made from the same underexposed color transparency. All were made with the aid of the Birch-Field Variscope, and demonstrate the range of color correction it makes possible. The picture at the top has too much blue; the one at lower left, too much red. The lower right-hand version, gaining by the experience obtained in making the preceding two, represents a close approximation of the actual colors of the original subject.

PSM Photos by HUBERT LUCKETT

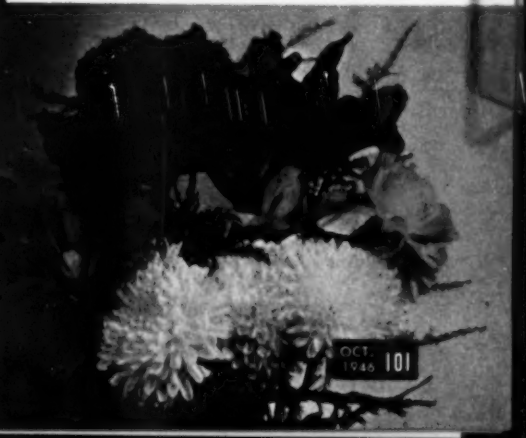
AFTER. The strikingly improved print above was made with the assistance of the Variscope, properly set to correct the color balance of the group of different flowers.



Here's how the Variscope works. P is one of millions of points on the transparency; P' is the image of P on the print. Midway between the two is the Variscope (B), viewed from top at right, which fits on enlarging lens (A) and separates the color into its component parts. Changing setting of diaphragm (C) alters the relative intensity of primary colors to achieve proper color balance.



BEFORE. Look at this picture, then glance at the same flowers above. Both prints were made from one properly exposed color transparency, but the reproduction below was made without using recommended color filters.



far as the construction and perfection of the Variscope are concerned. Actually, the three color bands are extremely complex factors. Each consists basically of one of the subtractive primary colors: red, blue and yellow. To the color in each ring has been added a certain amount of each of the other primaries. The proper amount for the best results and the width of the individual bands have been determined after long and painstaking trial-and-error experimentation. With nine variable factors—three colors, three intensities, and three band widths—the possible variations run into tens of millions. However, by a stroke of good fortune, the Variscope was perfected after a mere 1,200 tests. In developing the Iriscope young Birch-Field made more than 30,000 trials.

Basically, the uncontrollable factors in color photography resolve themselves into one major problem—the actual production of the various types of tripack color film and paper. In each case, these products consist of a simple base—film or paper—upon which are superimposed three separate layers of chemical substances. Each layer is sensitive to one of the primary colors and contains appropriate dyes and coupling materials. For proper color balance, the required thickness of each one of these layers is 5/1,000 of an inch, a coating thinner by many times than the thinnest sheet of tissue paper. And a variation of a mere 1/50,000 of an inch, while invisible to the naked eye, is sufficient to ruin the color balance in any picture. The mechanical difficulties involved in obtaining a sensitized layer with an over-all accuracy closer than 1/50,000 of an inch are practically insurmountable. In consequence, all tripack film and color paper must be corrected, both in exposure and printing, with a variety of filters.

The trouble with using filters doesn't stop right there, either. When light of any color mixture passes through a filter, it passes as a diffused mass of color, and some of the light of all colors is absorbed by the filter. The light that then reaches the reflecting surface—the color paper or the screen—is thus not only diminished in intensity but has been affected in all of its color components rather than just the one for which the filter was originally used.

The Variscope overcomes these difficulties because it is not a filter. It is based on the principle that light of any given color is a mixture of the primary colors in various amounts. It separates these colors as they pass through it and recombines them again at the focal plane. None of the purity is lost because each of the primary colors passes through its proper color band. At the same time, the *amount* of each color passing through the Variscope can be controlled by the irislike action of the mount.

Obviously, if the correct color balance is obtained for one color point, it will be the proper balance for all color points, or for the image as a whole, in the case of a single transparency.

From this, and from the illustrations on pages 100-101, the possibilities of the Variscope can be seen. It greatly simplifies laboratory technique by eliminating filters entirely, and by combining color control and enlarging into one simple operation.

Anatomy Students' Quiz Bird Is Three Other Creatures

DESIGNED to test students of comparative anatomy, the birdlike skeleton at right was built from the hind leg bones of a cat; the neck, wings, breastbone and backbone of a chicken, and the skull of a pike. Some students spotted the fabrication, but others identified it as anything from a pterodactyl to an "archeoptery." The oddity was created by Ward's Natural Science Service, of Rochester, N. Y., at the request of Dr. D. W. Davis, of William and Mary College.

STEEL by Prescription

Filling a blast furnace by the wheelbarrow load (above) was a back-breaking job in 1873. Lower right: using the optical pyrometer, in modern precision steelmaking, to measure temperature of molten metal in a 150-ton-capacity open hearth at the South Chicago works of the Carnegie-Illinois Steel Corp.

By HARTLEY E. HOWE

STEEL experts like to tell about the old-timer who heard a couple of cubs arguing about how much carbon there was in a piece of steel. He picked up the sample, broke it, tasted it, and said it was .40 percent carbon. Skeptics then sent the sample to the lab. It proved to be .39 percent carbon!

Millions of tons of steel have been made with such by-guess and by-gorry methods, but they are no longer good enough. Precision instruments now are taking the place of the accumulated skill of eye and hand—and human tongue. Today's expert, for exuring the exact extent to which tells the carbon content by measuring the exact amount by which the steel interrupts a magnetic field.

For years, steelmakers estimated temperature by plunging an iron bar into the molten metal. If the end melted off clean and square, the steel was "just right." Now an immersion pyrometer measures the electric current set up when wires of two different metals are heated at their point of contact in the furnace.

To measure the silica content of slag—important in checking on

A 200-ton ladle dumps molten iron into a furnace at the Great Lakes Steel Corp., where N-A-X High Tensile steel is made. This new-type metal uses chromium, zirconium, manganese and other alloys to make a product that is ductile, resists impact, fatigue, corrosion, abrasion, and has good welding properties.

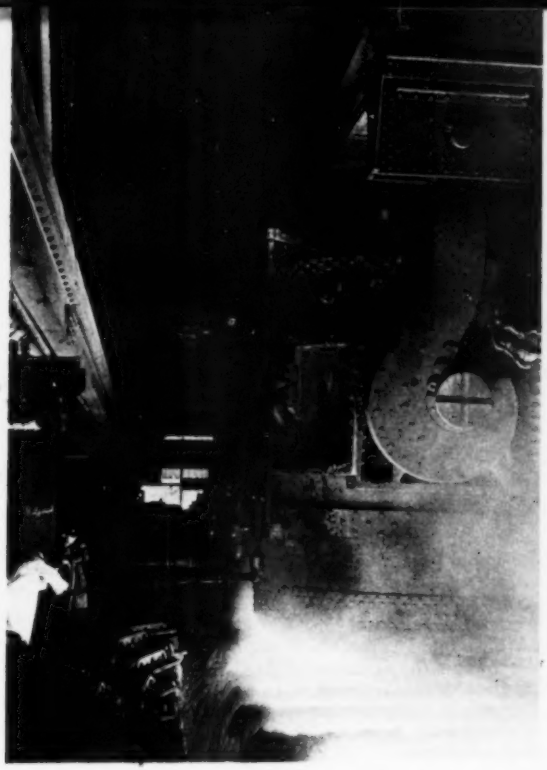
Tapping a 250-ton open-hearth furnace. The liquid metal runs into a ladle that will carry it to be poured and cast into ingots. Carefully controlled temperatures are vital in making prescription steel.

the progress of steelmaking—the old-timer used his eye. Now the slag is poured into a metal tube, called a viscosimeter, and the distance it runs down the tube in a given time tells the story.

This shift from shovel to laboratory methods makes tremendous change in the final product possible. Steel is no longer a single metal, but a family of thousands. From these the metallurgist can draw a metal suited to practically any specialized purpose—or concoct a new one almost as easily as a pharmacist mixes a prescription.

The jobs that steel must do nowadays vary as greatly as those of people. Structural steels that go into girders and beams lead a comparatively simple life. All they have to do is carry a static load—until a hurricane comes along and produces some highly dynamic effects against the outside of the building. Rail steel, one of the first of the special types and still the finest steel produced in large quantities, has to take the pounding and grinding of tons of heavy cars bouncing up and down. Another branch, the stainless steels, must stand the corrosive acids that go into making pickles —or photographic developers.

Heat-resistant steels must hold their



Here the 6-foot-long, 8-ton ingots are cast in iron molds. From this raw steel come locomotives, auto frames, furniture, and a thousand other products.

At slabbing mill, ingots are rolled until 5 inches thick, 54 inches wide, then cut to order. Thirty percent of original ingot is lost in the finishing.

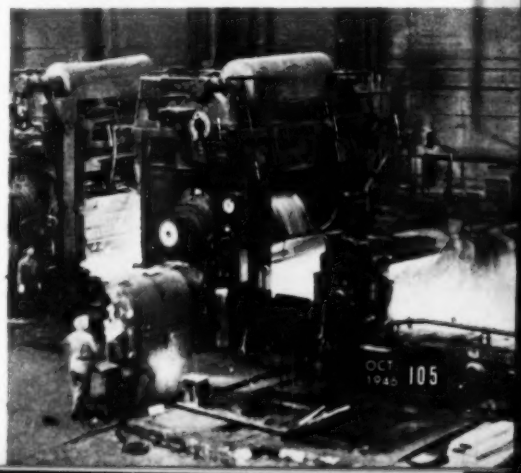
strength and shape while being repeatedly heated to 1,500 degrees F. and then cooled again. Other steels must endure the icy chill of quick-freezing equipment. Free-cutting steel must machine easily for screw-making. Tool steel has to keep its super-hardness while glowing red hot as it cuts into revolving metal. Steel pipes and ship plates must be easily welded.

Engineering steels—among the most important groups—must take every conceivable kind of load in such forms as automobile crankshafts. Spring steels must bend under a load—and bound back into shape. Electrical sheet steel must have special properties to save power in generators. And yet other steels must roll readily into plates, be easily drawn for wire, enamel smoothly for bathtubs, be highly magnetic for compasses, or even combine a hard surface with a tough core for armor plate.

To make these special steels, the metallurgist changes the chemical composition of plain steel. He varies its internal structure by heating and cooling it. He works it by hammering or stretching, which also changes the physical structure, or he combines such techniques.

Basically, steelmaking consists of removing impurities from pig iron or scrap. Now it has been found that some "impurities" can be helpful. Small quantities of phosphorus increase tensile strength, elastic limit and corrosion resistance. The right amount of sulphur makes a rolled steel easy to machine: sulphide fibers break off and keep the cutting edge free of chips. Silicon

At stripping mill, the largest in the world, ribbons of N-A-X steel 5 feet wide and 1/8-inch thick are rolled at a rate of 22 miles an hour. A single ingot will produce a 500-foot-long ribbon.



improves the bounce of spring steels, jacks up the tensile strength of structural steel, and is particularly helpful in making special steel for electrical apparatus.

Tiny amounts of other elements improve the quality of steel—just why, nobody knows. A touch of boron—one of the best of these "needles"—so small that commercial analysis cannot detect it in the finished metal, makes steel both harder and stronger without losing its toughness.

Changes Wrought by Alloys

More important are the pure metals that are alloyed with steel. Chromium not only hardens it, but provides strength at high temperatures. Even more valuable is chromium's high corrosion resistance, which makes stainless steel resistant not only to rust but to the corrosive liquids used by the chemical industry.

Stainless steel is made of 18 parts of chromium with eight parts of another common alloy, nickel (the other 74 parts are steel). The nickel adds toughness. Manganese is another tough baby that makes steel stronger but not more brittle. Manganese also increases the depth of hardness—important since large pieces of steel do not harden equally all the way through. All commercial steels contain at least a little manganese.

Tungsten, which comes from the interior of China, has the highest melting point of any metal. As an alloy, it enables steel to keep its hardness when heated and is used for the tools that cut metals at high speeds. Molybdenum has the same function—and since it comes from Colorado it has been a lot easier to obtain in recent years. "Moly" has also replaced scarce nickel and chromium in structural steels.

Copper increases resistance to atmospheric corrosion and at the same time builds up strength and hardenability. Cobalt—very expensive—is primarily a toughener, used together with tungsten. Aluminum is often combined with chromium to produce the proper grain in a surface-hardened steel. Vanadium, which comes from mines high in the Andes, improves tensile strength and elasticity, and is particularly important for increasing resistance to fatigue—the tendency of steel to fail under certain conditions of repeated stress.

Complex Ingredients

Some of these alloys are used singly—many are combined into complex alloy steels. In World War II, when imported nickel and chromium became scarce, it was found possible to replace many standard engineering steels with new types. In these National Emergency steels, small amounts of several alloys are used to produce steel equal to that containing large quantities of one or two of the scarce alloys. The future of these new NE steels is still in doubt. They use smaller amounts of expensive virgin alloys, but they require much more care in sorting the scrap before dumping it into the furnace. It is yet to be determined which is cheaper.

New alloy combinations are constantly being discovered. One of the more recent ones—the high-temperature-resistant steels—made possible our high-level bombers and the superspeed jet planes. The turbosuperchargers that enabled aircraft to fly almost eight miles above sea level had to endure the fiery breath of the flaming exhaust gases that drove them. Jet engines have to withstand even higher temperatures—up to 1,500 degrees F. or more in the rotor blades. Any ordinary steel loses its strength at these temperatures and begins to "creep" or change shape under stress. But metallurgists developed new alloys using nickel, chromium, molybdenum and other elements—and made possible speeds approaching that of sound.

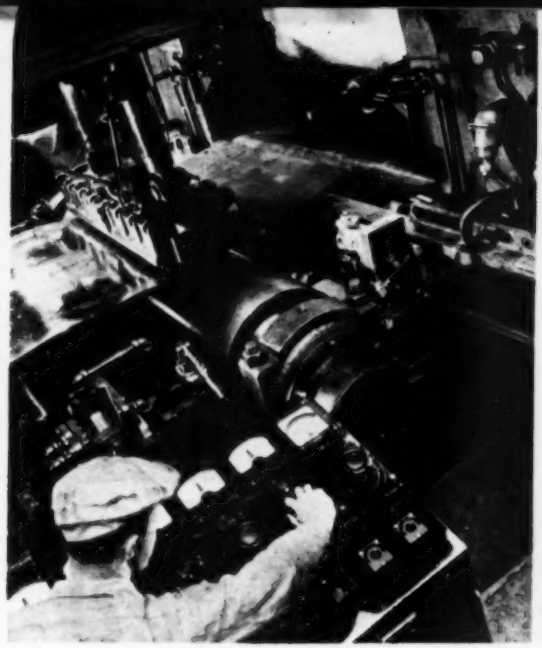
Now engineers are demanding metals which will take even higher temperatures—up to 3,000 degrees. The researchers are scratching their heads—and going back to their laboratories.

Giving Steel Added Strength

Working steel—forging it, rolling it, drawing it out into rods or wires—increases its strength. These processes usually come in the final fabrication. Long before, the steel has been strengthened by heat treatments that alter the internal structure of the metal, making the grain finer (which improves the quality) while relieving the internal stresses (which make the steel brittle).

The Saracen swordsmiths took a slave with them out into the desert where they forged their famous Damascus blades in secret. When the sword reached a certain color in the fire, indicating the right temperature, the smith would pull it out and plunge it into the body of the slave. That unfortunate's internal heat was, of course, close to 98.6 F., and he provided a controlled-temperature cooling bath.

Modern heat treatments are less dramatic but considerably more effective. The steel is first quenched by heating it above its critical temperature (varying with its composition), then suddenly cooling it. The heating dissolves the alloys and forms a solid solution of carbides in the ferrite



Automatic controls in strip rolling have replaced brute force and tedious hand measuring. Here, workman controls speed of mill, pressure of rollers, thickness of plate, etc., on a high-speed strip mill.

Even detection of pinholes is done automatically. As steel rolls under electric light, a photoelectric cell sets up a current if light passes through. Bethlehem Steel developed this detector apparatus.

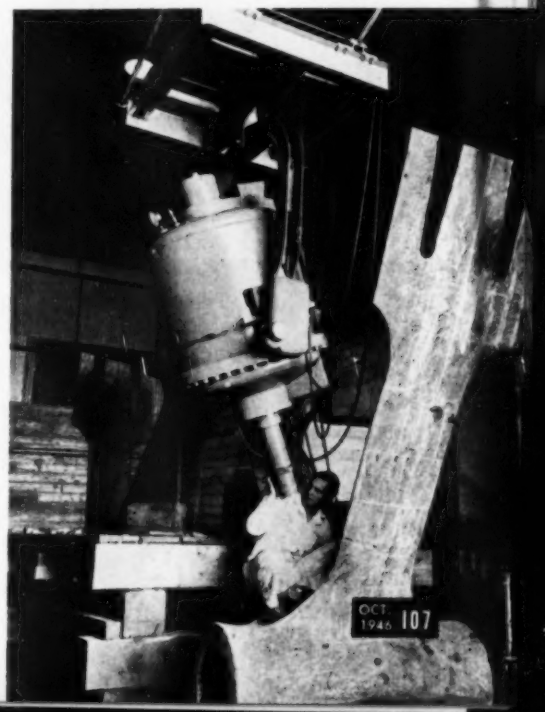
created by the iron in the mixture: the cooling again changes the molecular structure, to martensite—a mixture of carbides finely dispersed in the ferrite. The finer the dispersion, the finer the steel, but since martensite is brittle as well as strong, the steel is then tempered. It is again heated—not quite as much as before—and the carbides and ferrite rearrange themselves in a coarser structure. When the steel is cooled a second time it is somewhat softer but a good deal tougher.

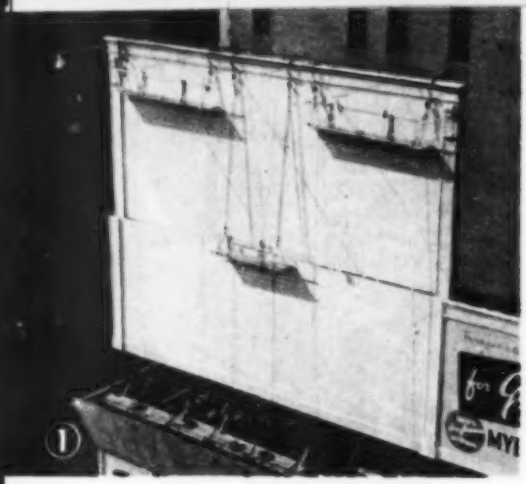
Additional heatings and coolings may be carried on through annealing and normalizing processes that further modify the structure. Recently experiments have been in the opposite direction—freezing steel to temperatures far below zero to make it harder. Here the research metallurgists are coming up against the fundamental structure of matter, exploring why some things are strong, some weak, some hard, some soft.

Steel men just smile when they hear about the coming "age of plastics" or "age of light metals," which some prophets are proclaiming. They have what is today America's biggest industry and the world's most versatile material.

But they also know that steel will have to fight to keep its place as the king of metals with new prescriptions for new uses.

Penetrating X-rays also have a place in the modern steel industry. Below, a technician concentrates the pinpoint beam of a powerful X-ray machine on a gigantic casting to search out internal flaws. The machine can be moved back and forth, and its long, tube-like end can be swung in a vertical arc.



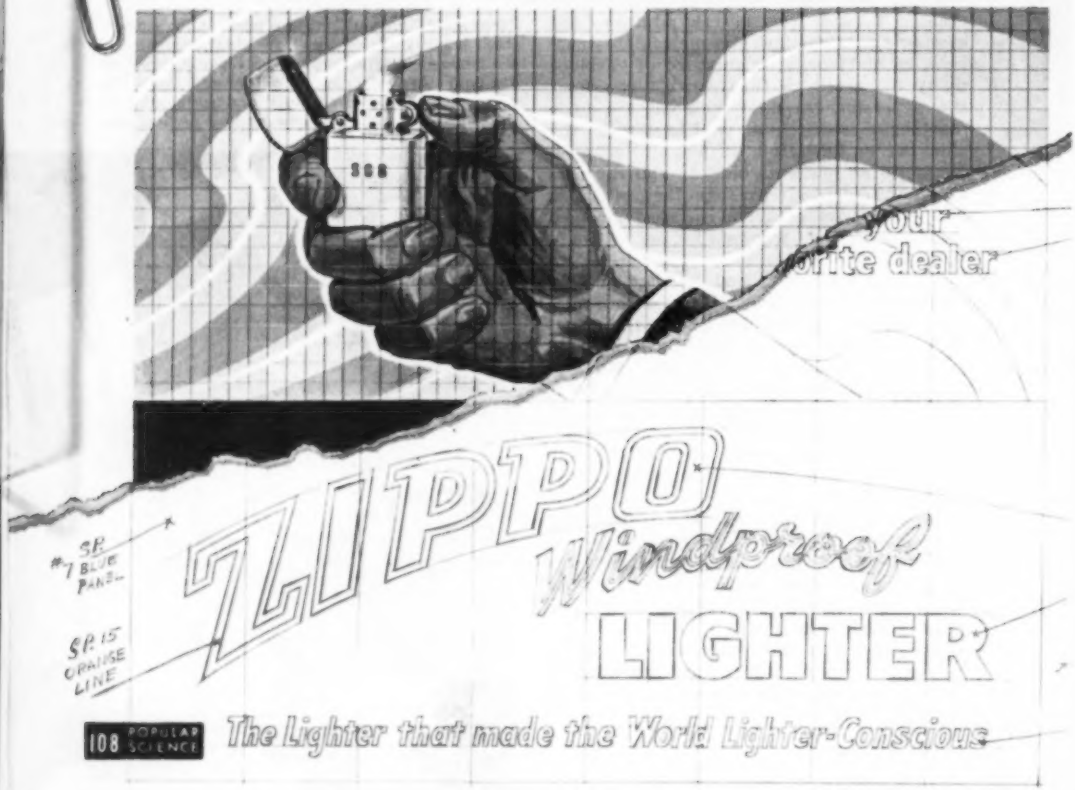


1

2

How a Sign is Painted

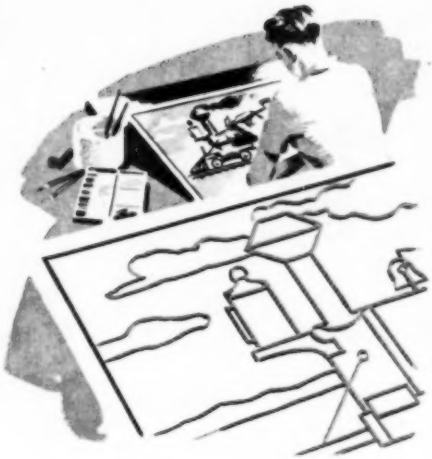
A water-color drawing, scaled one inch to the foot, is squared off by the pictorial painter for his own guidance in putting such outsize art work on a board with raw paint. This is shown below, overlaid on an outline sketch of picture and lettering that is keyed to serve as a color chart.



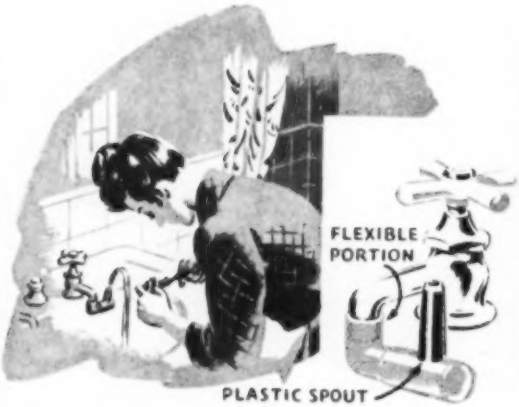
Neck-craners who watch skyscraper artists often wonder how they work out the big painted boards. These pictures of the jumbo sign above Fifth Avenue and Forty-second Street show the successive steps. (1) First, the old sign is blocked out. This is done by a crew (five men) that puts up the scaffolding and gives the entire area one heavy coat of gray paint or, in the case of a rush job, a coat of quick-drying white. This crew also delivers in a metal box all the cans of colored paints needed for the new sign. (2) Then a pictorial painter and a helper, who does the lettering, take over. They square off the board and, with chalk and indelible pencil, sketch the picture and lettering of the new sign. (3) These scaffold Rembrandts carry only their brushes and a few tubes of paste colors that the pictorial man may need to bring out highlights in the art. (4) The 41-by-51-foot sign (below), completed in four days, will retain high visibility for at least six months. Arrow points to the box of paints.

PSM PHOTOS

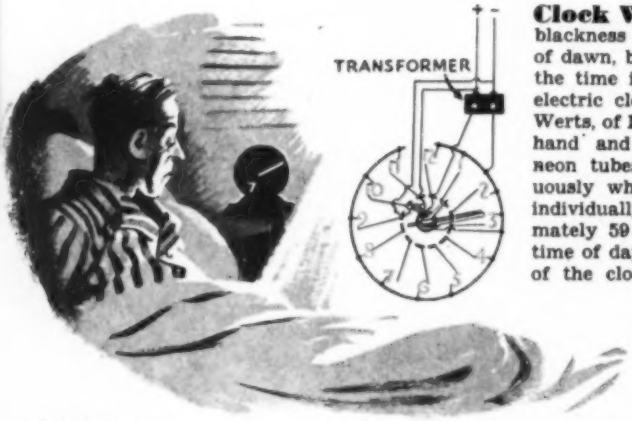
NEW IDEAS from the INVENTORS



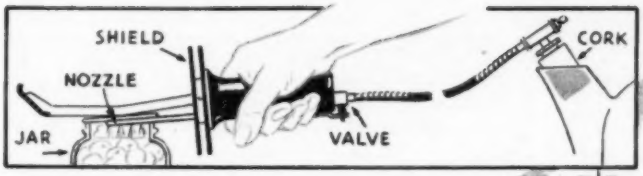
Keeps Colors in Line. A resin-and-heat treatment of the printed outlines of pictures in children's paint books, devised by Will H. Connelly, of Park Ridge, Ill., prevents water colors from running and marring the painting. In printing the pictures, resin is applied to the wet ink; then, under heat, the lines swell or puff up, forming slight barriers or dams between the sections of the drawing to keep colors separate.



Faucet Fountain. Drinking from a faucet is made a simple matter by the easily attachable invention of Paris Cambs, New Haven, Conn. A plastic spout, which can be turned in all directions on its axis, is attached by a flexible elbow to the downturned outlet of a faucet of any shape. Turned upward, it provides an easy-to-reach drinking fountain that eliminates the need for glasses, which may become unsanitary in the bathroom. The position of the spout can be quickly adjusted to point the stream of water in the direction needed. Since the diameter of the spout is somewhat smaller than that of the faucet, the water issues at increased force.

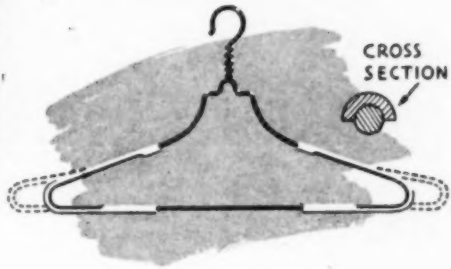


Clock With One Hand. In the blackness of night or at the first light of dawn, bleary-eyed sleepers can tell the time in a wink by means of an electric clock devised by Howard D. Werts, of La Salle, Ill. It has a minute hand and hour numerals made of neon tubes; the hand glows continuously while the numerals light up individually and stay on for approximately 59 minutes, according to the time of day or night. The mechanism of the clock is conventionally operated on ordinary alternating current, but a transformer is used on the current for the illuminated minute hand and hour numerals.

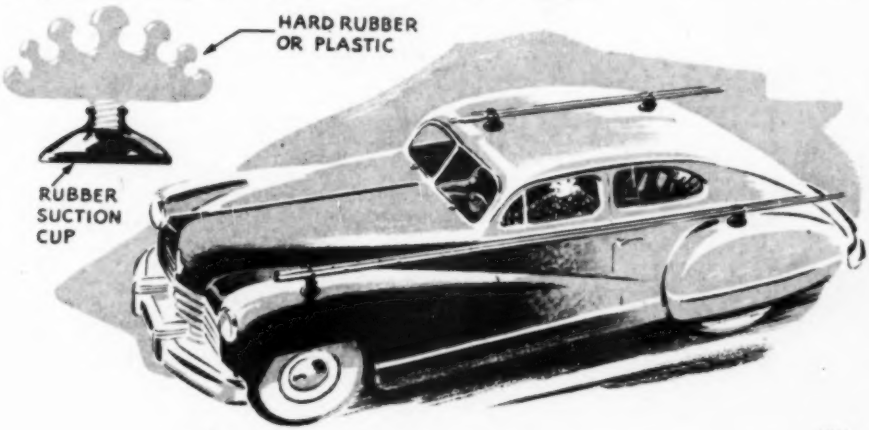


Teakettle Powers Sterilizer. A flexible extension from the spout of a teakettle, invented by Richard H. Wolf, of Gary, Ind., delivers hot steam to sterilize jars of canned food. A spring-controlled pressure arm above the perforated nozzle helps the canner clamp the lids on immediately after applying the steam. When a cover, held between the short steam nozzle and long, flat metal pressure arm is placed over a jar of hot food, steam is admitted through a finger-operated valve.

Adjustable Clothes Hanger. Since coats and dresses vary considerably in shoulder width, William M. Gallagher, Oklahoma City, has contrived a hanger that can be adjusted to nearly any size of garment. Shaped like an ordinary wire coat hanger, the invention adds two tubular shoulder extensions that slide over the base wire to enlarge the spread. The hanger can be expanded for clothing of all dimensions.



Fishing-Rod Holders for Cars. Originated by H. M. Wood, of Madison, Wis., for the benefit of those who wish to carry fishing rods or other poles conveniently on automobile trips, this contrivance consists of a pair of hard rubber or plastic racks along which the poles may be laid. The racks are screwed into rubber suction-cup bases, which are then attached in the usual manner to the top or fenders of the car. They may easily be used in the same way on boats. Single racks might be useful for stacking paint brushes or hanging up tools in workshops.



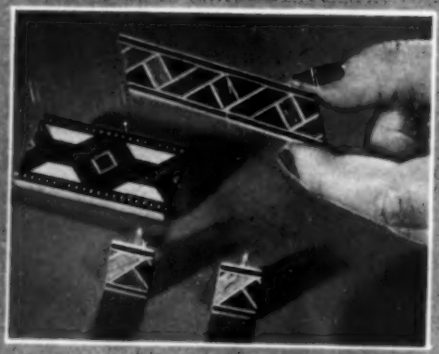
CRAFTWORK

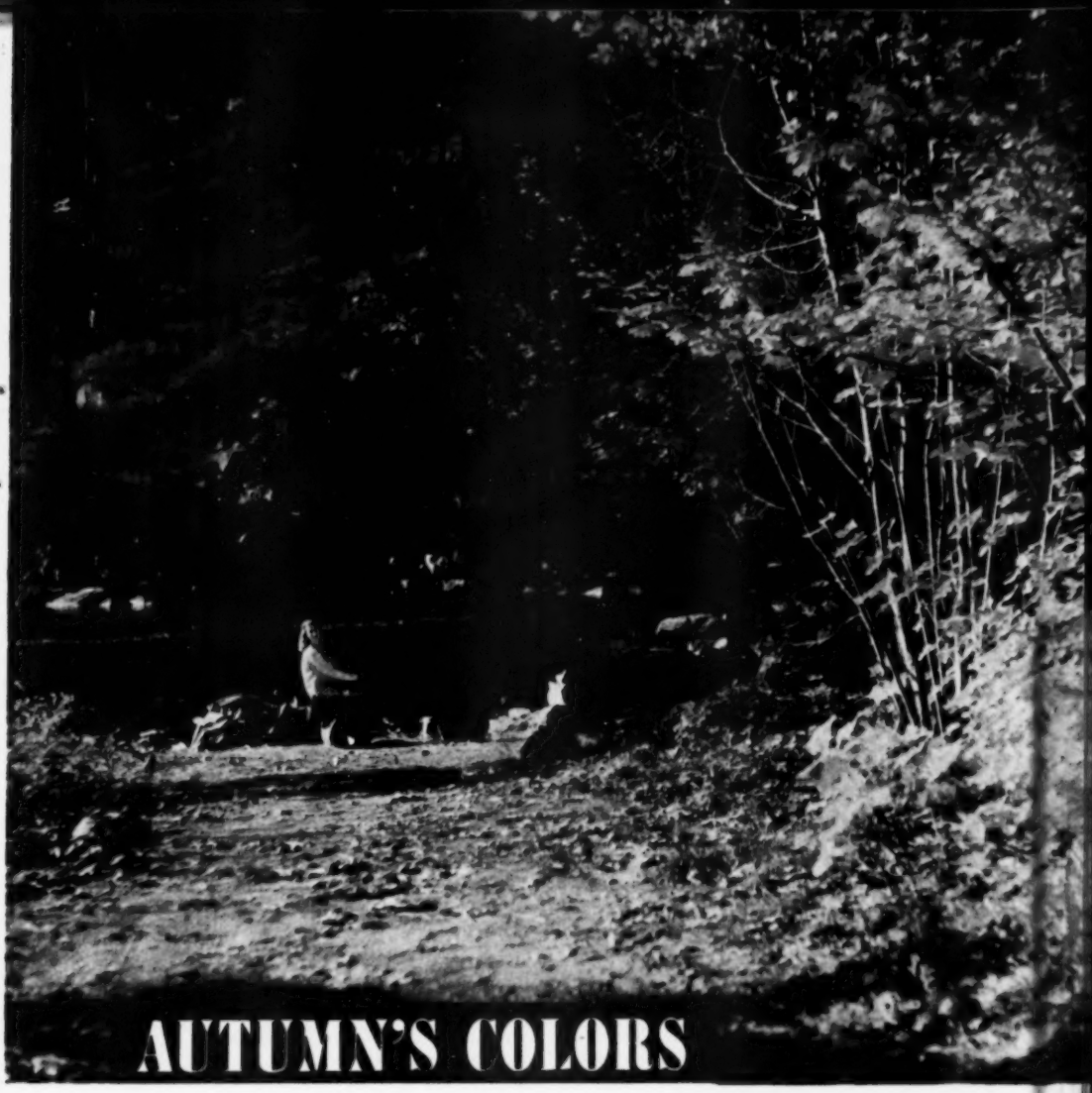
PROJECTS OF THE MONTH

Sturdy wheels salvaged from the old wagons of pre-automobile days are in style again, this time as antiques. Beginning on page 148, Eric Sloane tells how to turn them into furniture.

Extra-long rubber carries Sky Climber (left) to a high altitude, while a folding prop and the deep undercamber of the wing and tail insure a slow, flat glide. Turn to page 156 for building plans.

Scraps of colorful strip inlay left over from furniture making have been put to a novel use by one ingenious craftsman. As seen below, he makes jewelry of them. Details are on page 150.





AUTUMN'S COLORS make colorful photos

Bright Hues of This Season Invite Your Camera.

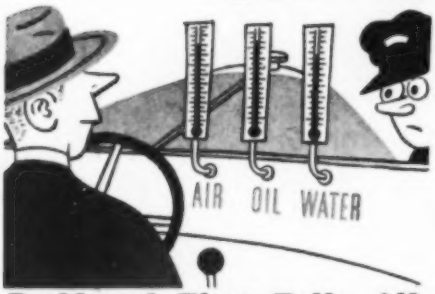
AUTUMN challenges every photographer to try his hand at color pictures, for at this season nature sparkles with opportunities for vivid transparencies and prints.

Yet fall also has its photographic pitfalls. For example, the crystal-clear air and bright colors may deceive vou into underexposures, moisture-laden lenses may blur your negatives, and the decreased contrasts produced in nature by the softer sunlight may result in poor print quality. In an article on fall photography, beginning on page 182, Don Storing suggests how to handle your camera in this fine season.

I'd like to see them make

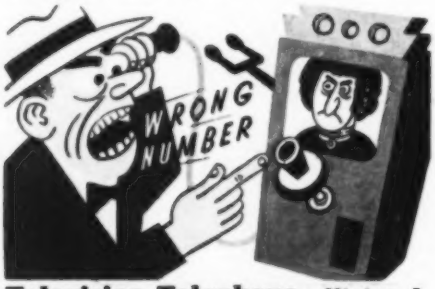
Cartoons by SYD LANDI

Everybody has his own pet idea of some gadget he would like to see in general use. What is YOURS? *Popular Science Monthly* will pay five dollars for every such suggestion that its editors decide to publish.



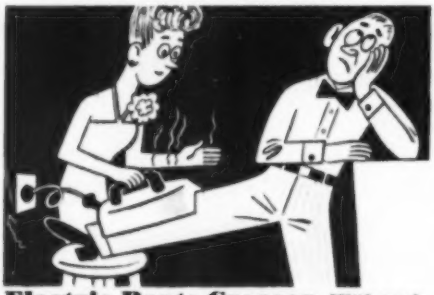
Dashboard That Tells All. Gauges to show the motorist exactly how much air is in the tires, how much oil and water in the engine. Suggested by L. R. Ruegg, Lake Mills, Wis.

Beds Hung from Ceiling. Using a pulley system, beds could be raised when the floor needed dusting or adjusted to suit an occupant's whim, says Mrs. R. Kash, Cincinnati, Ohio.



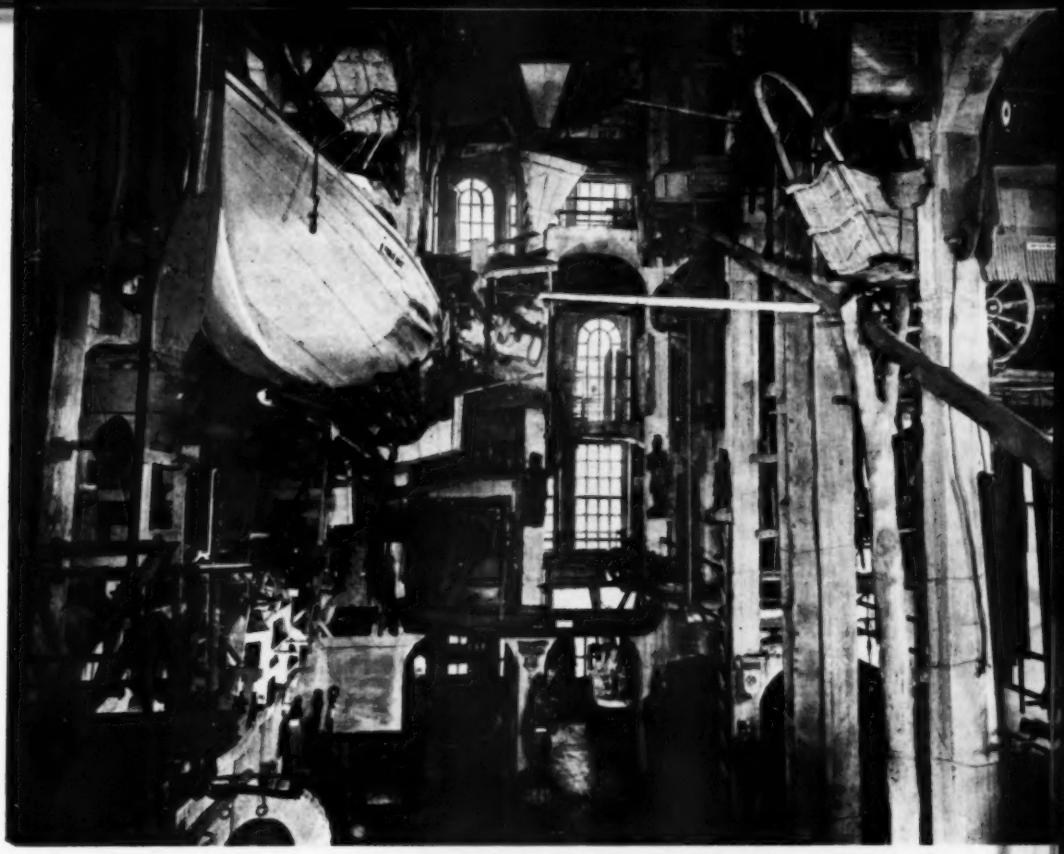
Television Telephone. Victor J. Tunison, Trumansburg, N. Y., believes it would be an advantage to push a button and be able to see as well as hear the person to whom you are phoning.

Palette for the Palate. Having wrestled with buffet luncheons, Bruce Deutsch, Clarksville, Tenn., suggests a safety-first service tray shaped and thumb-holed like an artist's palette.



Electric Pants Creaser. With such a gadget, made to fit into any ordinary socket, Stephen J. Stack, Plains, Pa., believes that a man's trousers could always have a knife-blade edge.

Pain-killing Drill. James H. Gillen, Jr., of Seattle, thinks patients would exclaim, "Doc, it's a pleasure," if dentists could use a liquid anesthetic that would percolate through drills.



A battered but sturdy whaleboat (upper left), a Conestoga wagon (upper right), and a well sweep (right) with a 25-foot cretched support are among the larger tools and mechanisms housed in the Bucks County Historical Society's four-story central hall.

Old-Time Tools Tell History

Our forefathers had their gadgets to make life easier in the days before steam power and electricity.

By LEIGH MITCHELL HODGES

IN A huge concrete museum in Doylestown, Pa.—one of the first wholly "poured," and woodless from bedrock to roof ridge—some 26,000 original tools, implements and utensils tell a vivid story of how Americans lived and worked before steam power came into use. This major collection of its kind reflects a broad range of inventive and manual skill, and impressively emphasizes the part played by stone, wood, and metal in the household and field activities of the nation from Jamestown and Plymouth to the turn of the 19th century.

True to Emerson's dictum that "an institution is the lengthened shadow of one man," this free museum is a monument to the zeal and energy of the late Dr. Henry Chapman Mercer, who gave it to the Bucks County Historical Society in 1916, 14 years before his death. He was a local boy, born to ease; was graduated from Harvard, and was lured from the law by a flair for archaeology and folklore. While exploring prehistoric caves and Indian haunts in Pennsylvania he stumbled on many reminders of later pioneers—in barns, attics, and junk

piles. These crude but efficient products of primitive handicraft spurred him to a wider search for such relics of early days, and for 40 years he spent much of his time wandering through his own and neighboring states, mostly on bicycle, gathering them in. Many items have been contributed by visitors.

The collection is intended to show the mechanical progress and development of industry. Through the early centuries of man's rise from savagery, all agricultural and mechanical labor was done by hand. Gradually man began to use his brain more and his muscles less and to conceive and produce machines that utilized animals for motive power. The greatest forward step made in the arts and crafts, after the discovery and use of fire and possibly the wheel, was the harnessing of wind and water power by means of the windmill and the water wheel. By the middle of the 15th century certain heavy occupations were carried on almost entirely by one of these means or the other.

Decorated with brilliant tiles designed and made by Dr. Mercer, museum's donor, the original library room with its concrete floor, walls, bookshelves, window frames, and groined ceiling is a dependably safe place for its priceless books and old documents.

Practically every art, trade, profession and calling that the nation's builders have followed are represented in the Doylestown museum's 69 gallery rooms and alcoves and in the great central well where the larger items are displayed. Every exhibit, from the lard lamp to the lumbering Conestoga wagon, is a genuine antique.

"The collection offers a new way of studying and illustrating history," declares Horace M. Mann, curator of the Historical Society. "Not the political or documentary history of nations, but of man's striving to contend with the forces of nature and supply his creature needs."

Someone has called the museum a "wilderness of wonders." And thousands of Americans and foreigners have wondered at the ways shown there for conquering the wilderness to which the colonists came, or in which they were born. At the museum visitors see an illustrated story of long labor and hard living; of patience and persistence. It is the real story of our independence, which was mothered by *self-dependence!*

The museum has more than a score of cigar-store Indians and other wooden figures, including (left to right) Pocahontas, Punch, a page boy, and a postman. They were the spare-time products of the woodcarvers who shaped the human forms that graced the prows of early clipper ships.

More of Dr. Mercer's colorful tiles, decorated in relief with scenes copied from cast-iron stove plates that date back to Biblical times, frame the old-time fireplace (below) that is in one of the museum rooms. The close-up at the left depicts "The Family Quarrel" — husband and wife fighting, urged on by flying demons as the children protest in vain.

This Concord coach is 110 years old and saw service for many decades between Boston and the immortal Wayside Inn, Sudbury, Mass. It is still in first-class condition.

Highly skilled fingers, with benefit of scissors, dyes and wire, fashioned this beautiful bouquet from feathers of a White Leghorn, and it looks as decorative as it did when it was made, 75 years ago. No Victorian parlor was complete without a glass-domed cluster of feather or wax posies.

Built 150 years ago by Patrick Lyon, then America's leading maker of fire-fighting apparatus, the hand pumper below was hauled and handled by Philadelphia's leading families and saw service for 45 years.

Hand-chiseled from a log of oak, this big screw—nine inches in diameter and six feet long—was used in eastern Pennsylvania until 50 years ago to supply the squeezing force for a huge "beam" cider press. The oaken beam into which this screw fits is 28 feet long and 15 inches square, and pivots on a stout upright. Through hand-turned action of the screw, the opposite end of the beam was slowly forced down on a wooden block that fitted into a slatted container filled with alternate layers of ground apples and rye straw, and the juice flowed into a wooden trough.

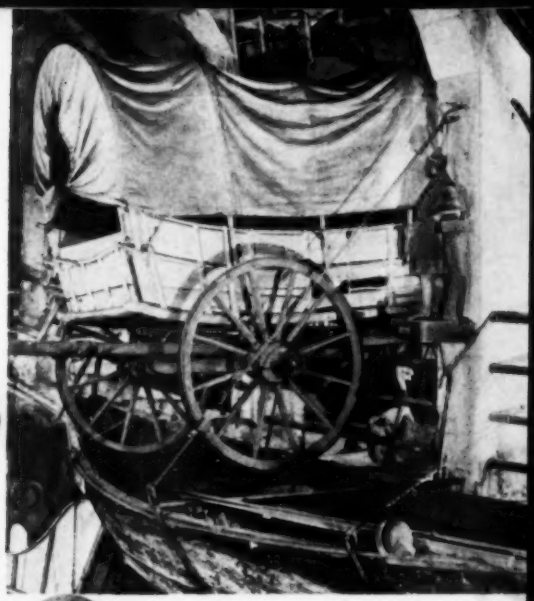
"The Bible in iron." Here is part of the museum's prize collection of 400 iron stove plates, the oldest of which was cast in Germany in 1567; an American-cast plate dates back to 1726. These artistic relics of the first attempt at central heating picture mainly Scriptural scenes. Averaging two feet square, five plates were bolted together, forming a backless "box" (lower left) that fitted over a hole cut to the fireplace.

Some of the comb-making tools shown below belonged to Michael Crouse, of Lancaster County, Pa., who left his bench to fight with Washington's army and who used them at Valley Forge to make combs for fellow soldiers. Transforming a cattle horn into a hair tool was a tedious process that first required the horn to be heated until soft enough to be slit and flattened, as seen on the "shaving horse" at left. There held tight on a clamp, it was knife-shaved to proper thinness; then the blank form was sawed out of it and fastened in one of the oblong clamps on the bench. After the teeth were cut, the ends were rounded and the edges smoothed.

Except for a few windows that can be opened for ventilation, the thousands of panes that admit daylight or enclose museum cubicles are set in concrete sash. Doors are of metal and glass, as shown in this view of the small room that houses the collection of threshing implements. Dr. Mercer planned the fireproof structure as it went along from day to day, without aid of an architect, and did much of the work.

Synonymous with the perils faced by American pioneers is the typical covered wagon, at right, which was used by Thomas Hovenden (1840-95) as one of the models for his famous painting, "Westward Ho!" It is a well-weathered reminder of the slow, dangerous journeys settlers made across the plains in quest of gold or free homesteads.

PSM photographs
by HUBERT LUCKETT

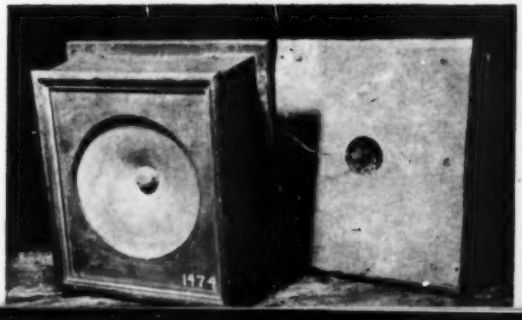


The sturdy hobbyhorse (left), bearing seams and patches that tell of long and hard use, was the delight of some child more than 100 years ago. This white-pine mount and other homemade toys and rag dolls share a room of their own.

The ingenious meat chopper below was a time-and-labor-saver in preparing the makings for sausage, scrapple and mincemeat. With the aid of gears, driving belt and ratchets on the revolving shaft, the hand that turned the wheel caused the chopping table to turn and the blades to rise and fall, mincing the chunks of pork, beef, or apples spread on the circular wooden block. The device was used until recently by many German families in Pennsylvania.

The pen was mightier than the typewriter when these crude machines were in their heyday. The Columbia Typewriter (right, above), patented in 1885, was pushed to the limit at 20 words a minute. The contraption beside it has such modern touches as "cap" shift and bell.

The tension telephone set (below) was found in an old carriage factory in Bucks County, Pa. The two-way "talkie" was used in the '80s and operated without batteries; a wire stretched tight between two drumheads of vellum or parchment could carry the voice.



A workman lays the outer copper sheeting on the roof of the 13-by-26-ft. chamber. After the copper walls were installed, the entire room was sheathed in an asbestos-base wallboard for fire protection.

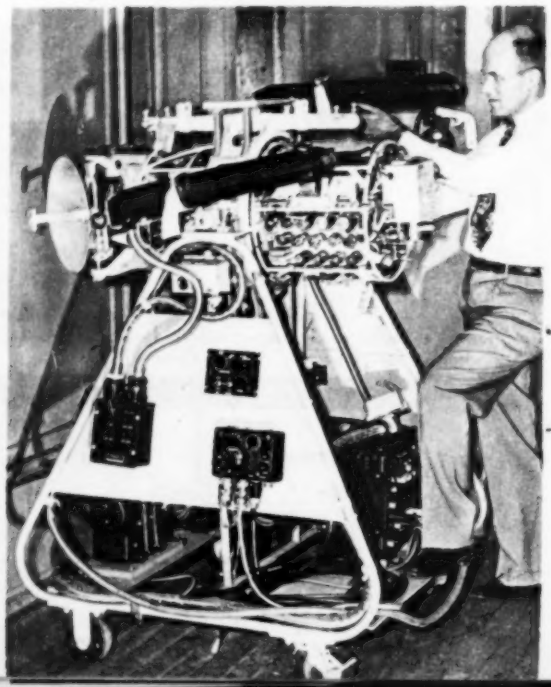
Copper-Lined Room

"PERFECT" FOR RADIO TESTS

A COPPER room within a copper room, built with lumber that not even a pencil has marked—that is the formula for a radio-testing chamber in which conditions are as nearly perfect as man can make them. Such a room, pictured on this page, has been built at the Curtiss-Wright plant at Columbus, Ohio. Double copper walls bar outside interference, and inside interference is eliminated by construction details: complete air conditioning, all wiring in rigid conduits, no fire sprinklers or other metal objects to hamper shielding. Even the kiln-dried, oil-treated lumber is unmarked, because a pencil's graphite might lessen resistance between the copper walls.

The extra-heavy outer door is fitted into position to complete the room's protection against possible outside influences upon the complex radio devices.

W. L. Bauer, designer of the test chamber, checks a radar unit, one of many delicate mechanisms that can now be inspected under almost ideal conditions.



What the well-dressed airman will [illegible] to narrow the gap between what p[illegible] can do—and what men can stand.

How to Live at High Speed

By MARTIN MANN

The "Man from Mars" is an AAF pressure suit designed to supply pilots with sea-level pressures during flights that reach extremely high altitudes.

HOW fast can man fly—and live? In the gulf between the 600-m.p.h. speed that is his physical limit today and the 3,000-m.p.h. velocity of the fastest flying machine (V-2) he has devised lies the unexplored region of aeronautical science. Air Force and Navy scientists, assisted by researchers from many universities and laboratories, are rushing the development of safety equipment to keep man in step with the airplanes of tomorrow.

Already under test are new flying suits, parachutes, automatic releases, deceleration straps, pressure cabins, and quick-exit devices—all needed to overcome the extra dangers of supersonic speeds and ultra-stratospheric altitudes.

Wartime experience with 400-m.p.h. fighters gave forewarning of the difficulties to be expected in bailing out of high-speed, high-altitude aircraft. This important problem has been attacked at Wright Field, Ohio, by the design of an automatic three-piece escape set including a seat ejector that literally shoots the pilot clear of a plane, an aneroid parachute release, and the jerkless, nonswaying ribbon parachute. All are self-operating—the airman does nothing from the time he pulls the ejector trigger until he lands on the ground.

The seat ejector was developed to meet a need that existed even with airplanes considered slow by present-day standards: pilots jumping from the cockpit did not fall fast enough to escape being hit by tail surfaces or other obstructions. With the new Air Force device, the flier and his seat are shot 60 feet straight up in one second. A second automatic explosion then disconnects the strap holding the man to the seat and opens a small parachute to pull the seat away, leaving the man to fall free.

The propelling mechanism is a small

37-mm. gun mounted vertically in the cockpit behind the pilot. Instead of the usual projectile, a long tube, attached to the seat, fills the gun barrel. When the pilot pulls the trigger, near his right leg, the explosion of the 37-mm. shell expels tube, seat and pilot with almost instant acceleration to the 60-feet-per-second speed. This rapid acceleration would impose severe strain on the man, pushing him down into the seat with a force equivalent to 20 times his normal weight—much like the effect felt in an express elevator, but exaggerated hundreds of times. The harm this strain may cause, particularly to the spine, is still being investigated, although the first test with a human being was made without injury.

Once clear of airplane and seat, the flier still faces a double hazard. He must drop quickly to an altitude low enough to give him sufficient air—if he opens his parachute too soon he dies from anoxia (lack of oxygen); too late, he smashes into the ground. The aneroid parachute release eliminates both dangers by opening the 'chute automatically at a preset altitude.

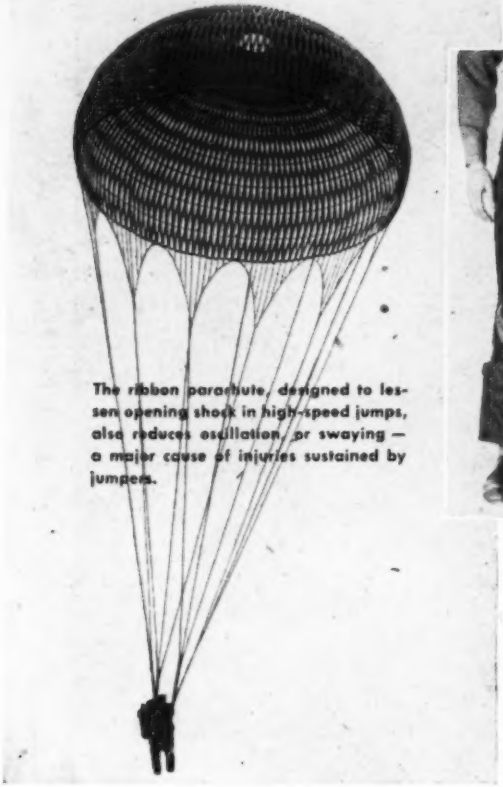
This new release is basically an aneroid barometer, which contracts with increasing atmospheric pressure. When the falling man reaches the predetermined altitude, the atmospheric pressure at that height causes the aneroid unit to contract and fire a small shell—about the size of a 12-gauge cartridge—which releases the rip cord. The aneroid unit can be set for a particular altitude at any time, on the ground or in the air, so the pilot can change the setting to meet the conditions of his flight.

An ordinary parachute, opened at extremely high speed and altitude, would jerk the flier hard enough to injure him or even rip the harness away. To prevent such accidents, a unique parachute made of interlaced ribbons is used. The ribbon parachute eliminates opening shock by permitting some of the air trapped under its lattice-like canopy to escape through the spaces between ribbons, so that the jumper slows down gradually to a safe rate of descent.

This gradual deceleration also makes the ribbon parachute valuable for high-speed jumps at lower altitudes. It has been tested at velocities as high as 375 m.p.h. with good results.

Even this new escape set will offer protection only up to 450 m.p.h., reports Brig. Gen. Malcolm C. Grow, the Air Surgeon General. Tests indicate that the air pressure at higher speeds would be too great for the human body to withstand safely. For bailouts at extremely great velocities

With his right hand on the trigger, a GI laboratory worker assumes the bailout position in the pilot ejection seat (right). Just beneath his arm is the container that explodes and frees the pilot from the seat three seconds after it leaves the plane. In circle above is the seat (and a dummy) in action during a test ejection, at Wright Field, Ohio.



The ribbon parachute, designed to lessen opening shock in high-speed jumps, also reduces oscillation, or swaying — a major cause of injuries sustained by jumpers.

A jet fighter pilot models the G (for gravity) suit that helps him withstand centrifugal force in fast, tight turns. Details of the suit are shown in inset (U. S. AAF Photos).

and altitudes, Gen. Grow predicts the use of a pressurized cabin, or capsule, which can be ejected with the flier inside. A parachute would be attached to the capsule itself.

Another method of reducing opening shock in parachute leaps is being developed at the Research Institute of the Naval Medical Center, Bethesda, Md. Workers there, under the direction of Comdr. Howard R. Bierman, have designed a safety harness using a special undrawn nylon, which stretches inelastically (without recoil) to safeguard pilots in crashes. The harness could also be used to provide protection against most of the sudden jerk accompanying the opening of a standard parachute. Costing only a few dollars, the new harness has the advantage of economy over the ribbon 'chute, which is more than three times as expensive as the standard equipment.

The undrawn nylon harness also promises protection against "ram effect," or sudden deceleration, a danger which becomes vitally important at very high velocities. Engineers fear that, in the event of engine failure at supersonic speeds, air friction would slow the aircraft so sharply that passengers would be thrown forward and crushed—just as if the airplane had flown into the side of a mountain. The nylon harness might decelerate the occupants gradually enough to prevent harm.

High speeds introduce another unusual danger: blackout, or loss of consciousness in fast turns. In this case, a partial solution was found in special flying suits, called G suits, early enough for them to see combat use.

Blackout results from the tremendous centrifugal force acting on a pilot when he makes a tight turn at great velocities. This force pulls the blood downward from his brain, numbing it and causing temporary blindness or unconsciousness. Since the effect of centrifugal force on a pilot is similar to the action of gravity, it is usually measured in Gs, or the apparent increase of a man's weight over his normal, gravity-caused weight. Thus, standing still on the ground a man feels 1 G, while in a 2-G turn his weight seems to double, in a 3-G turn, triple, and so on.

The parachute worn by the handsome dummy at right is equipped with an aneroid release. Using it for a free fall to safe altitude, pilots need not worry about pulling the rip cord too soon or too late.

Interior view of a B-29's rear pressurized cabin. It provides livable pressures at high altitudes, but does not satisfy ultrastratospheric needs.

To keep the pilot's blood up in his head—where it belongs—in high-G turns, Air Force and Navy researchers, aided by the Mayo Clinic of Rochester, Minn., and the Berger Brothers Company, New Haven, Conn., developed special suits containing air-filled bladders that press against the abdomen and thighs to prevent blood from draining away from the upper part of the body. The supply of compressed air to these bladders is regulated by an automatic valve, controlled by centrifugal force. As G increases, the valve admits additional air to the bladders, causing them to expand and press more tightly against the pilot's body. Decreasing G lets air out of the bladders.

The G suit adds about 2 G to the average person's ability to withstand 5 to 6 G. Safe turns as great as 10 G have been reported, however, by P-80 pilots wearing the suit.

Since the faster postwar airplanes will undoubtedly require turns of still higher G, better methods of surmounting this difficulty are being sought. Now in the design stage are prone cabins, in which the pilot lies flat on his face. In this position blood would not be pulled down from his brain, with a resulting increase in G tolerance.

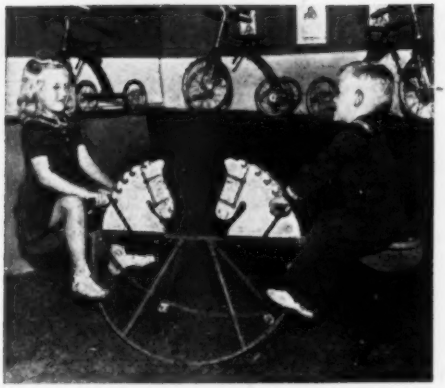
Invariably linked to greater speeds are higher altitudes, with the accompanying problems of oxygen supply and low pressure. Oxygen masks now in use furnish merely a partial solution. Pressure cabins, successfully employed in the B-29, can make up only part of the difference between livable pressure and ultrastratospheric pressure because of the danger of explosive decompression—sudden accidental loss of pressure that might seriously injure the occupants of the cabin. New pressure suits permitting complete freedom of movement are in work, but are not expected to be available for two years.

The speed of sound—only yesterday an apparently impassable limit—seems sure to be exceeded very soon by piloted aircraft. The Navy has already driven its ram-jet engine to 1,500 m.p.h., while the V-2 can reach 3,000 m.p.h. Now the No. 1 problem is no longer how fast man can fly, but how fast he can fly—and live.

For FUN and HARD KNOCKS

Fun in a bowl, and excitement, too. The toy is called a tumble top, and is made of aluminum with rounded edges. Allwork Co., of Oakland, Calif., manufactures it.

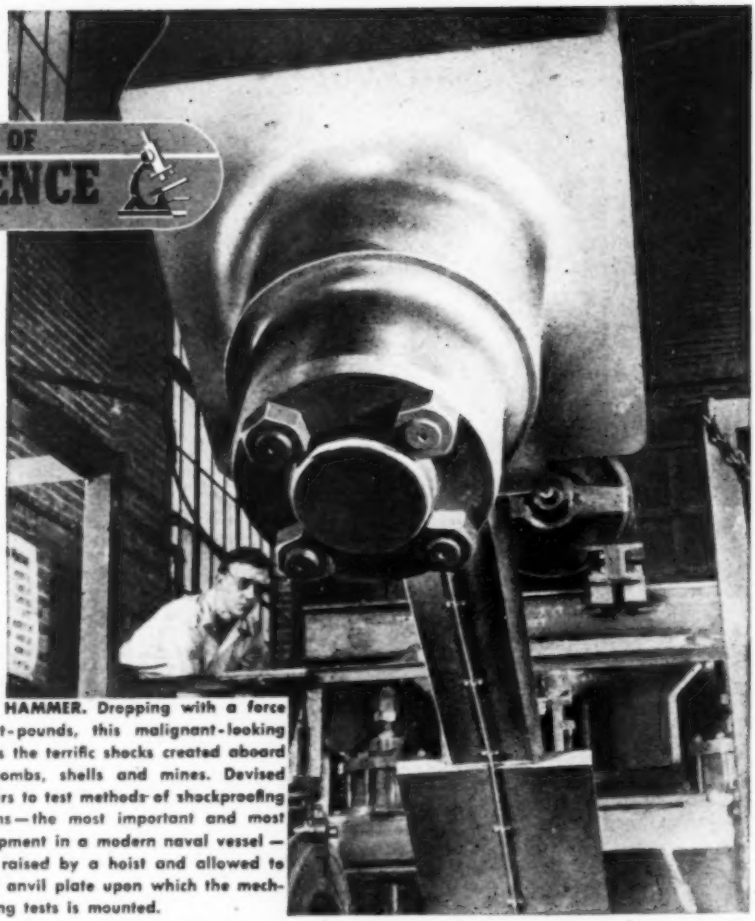
Practically crashproof, this rugged metal scooter has light pressed-steel wheels, which contribute to its strength. An automobile-type bumper adds safety.



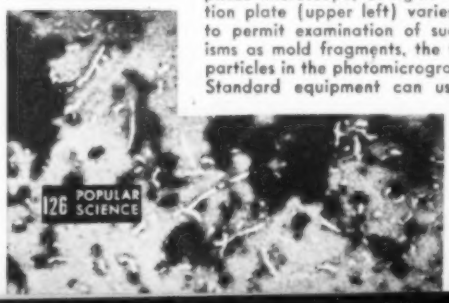
This cross between a rocking horse and a teeter-totter combines the best features of both. Pads beneath the seats act as shock absorbers when the frolicking gets rough. The plaything is made of tan metal by Houk Brothers, of Los Angeles.

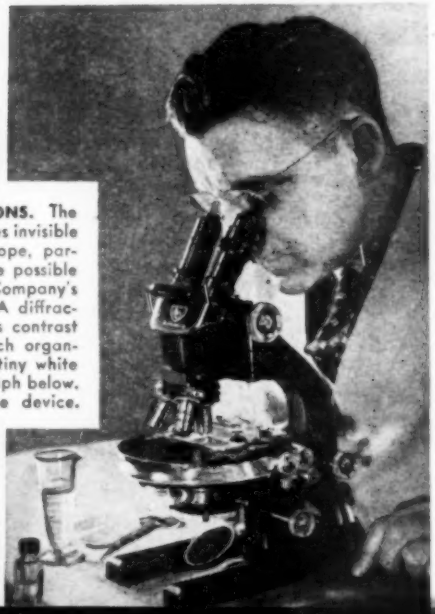
Here's a heavy-duty train, made by Timber-toy Co., Burbank, Calif., that challenges Junior's destructiveness. The locomotive, tender and express car are sturdily built of thick wood.

MARCH OF SCIENCE



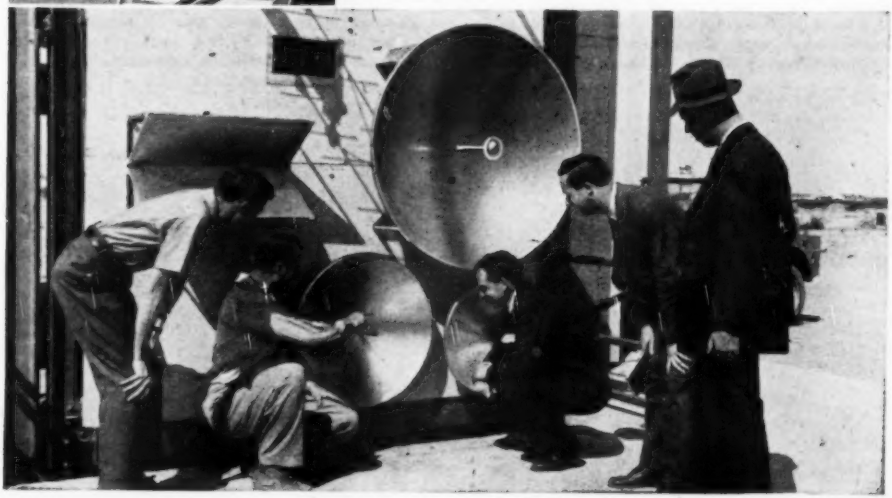
3,000-POUND HAMMER. Dropping with a force of 18,000 foot-pounds, this malignant-looking sledge simulates the terrific shocks created aboard warships by bombs, shells and mines. Devised by Allis-Chalmers to test methods of shockproofing electrical systems—the most important and most vulnerable equipment in a modern naval vessel—the hammer is raised by a hoist and allowed to drop on a steel anvil plate upon which the mechanism undergoing tests is mounted.





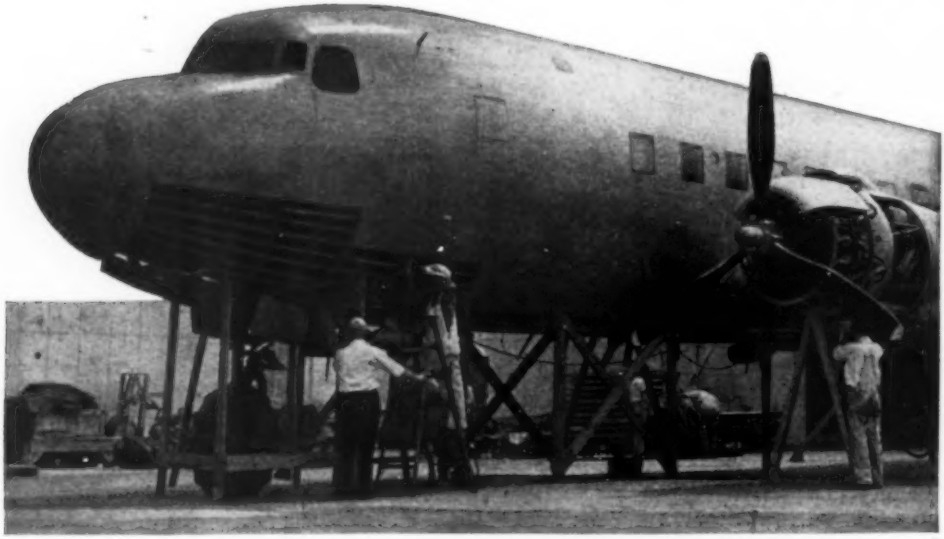
NEW MICROSCOPIC HORIZONS. The study of transparent substances invisible through an ordinary microscope, particularly living tissues, is made possible by the American Optical Company's phase microscope, at right. A diffraction plate (upper left) varies contrast to permit examination of such organisms as mold fragments, the tiny white particles in the photomicrograph below. Standard equipment can use device.

MAKING RADIO WEATHER-CONSCIOUS. Forseeing ranges of 2,000 miles for ultrashort waves, radar and television, Navy electronics experts in the Arizona desert are measuring the effect of atmospheric changes on high-frequency broadcasts. Transmitters (below), ranging from 170 to 25,000 megacycles, ride an elevator up a 200-foot tower (above) for broadcasts to two similar towers 25 and 50 miles away. Varying frequencies for different atmospheric conditions increases the range and also provides data for weather forecasting. At left, a meteorologist measures dew points by sending an automatic counter to different levels of the tower.



Planes that NEVER Fly

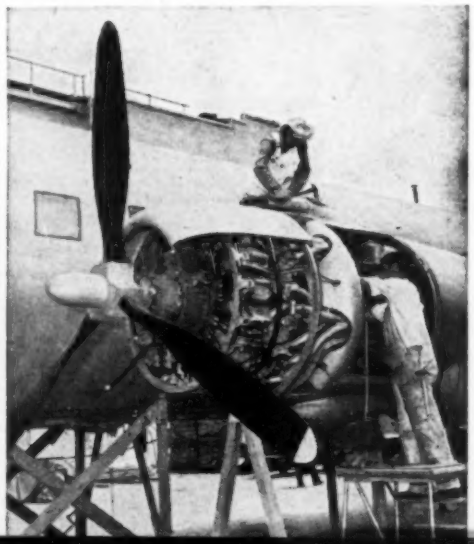
Mockups, the plywood predecessors of future air liners, save millions of dollars by showing engineers what they can do and how to do it.



Exterior of the huge wooden counterpart of the Douglas DC-6, first of which is already flying. Accompanying

An 80-pound plywood version of the plane's nose wheel is fitted in place for retraction into its well. This permits an accurate check on tolerances, calculated by engineers, before actual construction in metal begins.

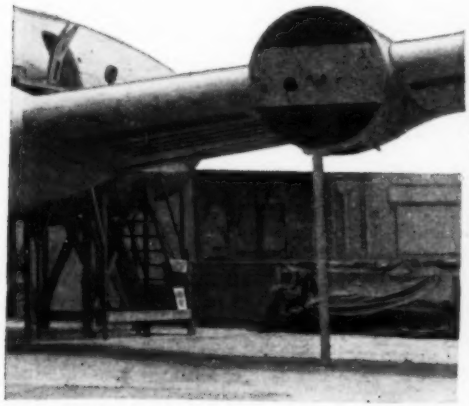
Mechanics install a dummy Pratt & Whitney engine, making certain that all accessories and lines will function and that all parts are accessible. The propeller is of wood, too.

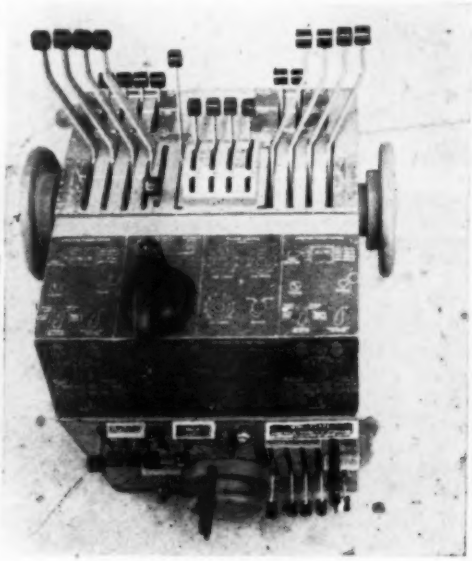


OF ALL the complex products of aviation, perhaps the most valuable are wood-and-fabric creations that have a top speed of zero miles per hour and never leave the ground. Somewhere in each sprawling aircraft plant sits at least one mockup, or model, of a plane that soon will ride the skyways. Made precisely to scale, the mockup is more important than any plane rolling off today's production line. Yet tomorrow it will be demolished.

The mockup resembles in detail the airplane it precedes. It contains duplicates or photographs of every working assembly and instrument. Engineers and designers swarm through it for months, remodeling various installations day by day until at last they create an air liner that will ply the world's airways. The precision model, costing $100,000 or more, enables engineers to solve problems that might cost millions if mistakes were built into a line of transports.

Every assembly in a mockup, like the control unit at right, must be faithful in detail. Manually operated devices are movable, but some instruments are only blueprints showing position.

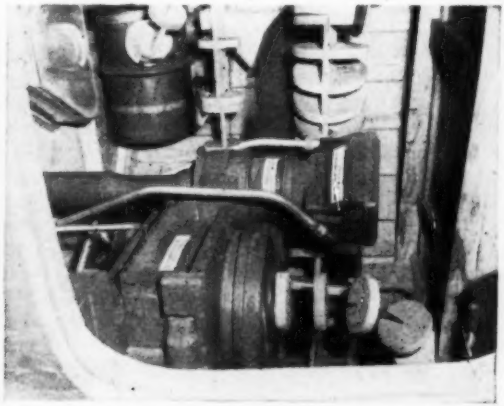




pictures show details of the mockup's construction.

Is the microphone within easy reach and the control column properly placed for the pilot's needs? The wooden imitations allow a check on position and workability.

A dummy supercharger unit (below) has round disks of different sizes to represent ducts required by the actual mechanism. Round shaft at the left transmits power from the engine, which is on the other side of the protective fire wall.



Locking mechanism of the big air liner's passenger cabin door is left visible for test purposes. The lock parts, which must function with precision, are among the few metal objects in the entire mockup.

Workmen fit parts into a model of the rest room, a segment built separately and then joined to the main structure. This is an example of the section-by-section procedure often used for large airplanes.

Any airplane starts as an idea. This first takes shape as a rough sketch, then progresses to engineering drawings. One of these is a three-view drawing showing external lines, and from it come cutaway paintings, usually in color, showing interior details. With these designs and paintings, the mockup men begin their work.

Sometimes they first build a space mockup, throwing together a skeleton framework with rough floor and paper lining. Into the space mockup go crude counterparts of the baggage compartment, lavatory, powder room, seats and berths, and models of landing gear, wiring and controls. It is all rough, but engineers representing both the manufacturer and the air line get a general picture of the airplane and decide how space is to be allotted.

When the customer has approved the space mockup, engineers proceed with design. Yards of carpeting appear on the floor, a few soft seats are bolted in place, windows are installed, and a workable combination seat-and-berth begins to operate.

As the mockup progresses, the first flying model of the airplane also takes form. This involves considerable trial and error, but engineers find it cheaper to build fast, and correct errors in the plane, than to perfect thousands of drawings.

Physically, a mockup is a simple structure. A transport designer knows that he must allow about four cubic feet of space per passenger for baggage on a transcontinental plane; 200 pounds for each passenger and his baggage; 40 inches for seats, center to center, and an aisle 18 to 21 inches wide. These are essentials of the passenger cabin. The pilots' cabin must be tailored to their needs just as carefully. They must have at least 10 inches clearance above their heads, and they need a minimum of 13 degrees of downward vision for landings.

To satisfy these requirements, the designer fixes the width of the aisle, locates the flooring at a level where a man 5 feet 10 inches tall can walk without bumping his head, and draws a circle. Then he begins building, section by section.

The mockup department at Douglas Aircraft's big Santa Monica plant, illustrated on these pages, provides an example of the sectional method: The DC-6, outgrowth of the war-famed DC-4, is projected. The circle has been inscribed. The first section to be built is eight feet long. Into this go flooring, seats and windows. It looks good to the engineers, so the pilots' compartment, based upon another circle but tapering to the nose, is added.

The entire mockup now begins to rise on scaffolding at the height of the completed airplane. Nonwarping spruce and white pine plywood form the shell, and steel spars extend outward to support the wings and en-

Another example of sectional construction is the baggage compartment, built separately to facilitate tests of a new monorail loading system using a preloaded luggage carrier. The carrier can be pushed inside the compartment (above) and then shoved sideways, forward or aft by means of overhead tracks and a switching mechanism. The mockup makes minor changes in such a system easy and helps iron out flaws.

Riding on a four-wheeled cart, shown above, the baggage carrier starts its trip up a track and into the compartment. Exterior and interior tracks are aluminum, another exception to the general rule of using wood.

gines. Wooden engines are fitted into the nacelles. Accessories are installed, removed, refitted. Pilots sit in the cockpit to study instruments and move controls. "Passengers" file in and out to test loading and unloading time—even the time required to serve meals.

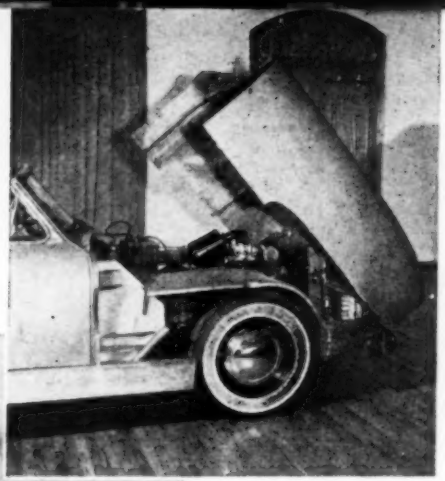
Lockheed's mockup of the Constellation cost $100,000, one-fourth of which went for materials, three-fourths for labor. Counting alterations, the same company spent nearly $200,000 on the mockup for its enormous Constitution, which will soon make its first flight.

Perhaps $200,000 sounds like a high price for dummy airplanes, but these are worth it. They save millions of dollars and bring a new transport off the assembly line months earlier than if the job had been done with metal. They allow executives to see what they're getting, and no air line orders a new plane from drawings alone.

Designers speak of the planes they build as having short, medium or long range; as being day or sleeper versions, perhaps de luxe with bar; as fast or slow. According to Lew Brown, Lockheed's mockup engineer, the mockup men describe them differently. "We," he says, "turn out squeezers, boozers, snoozers and dozers."

Interior of the mockup for Lockheed's Constellation illustrates progressive stages in the construction of seats and berths. Engineers, above, try out first rough installations for size to ascertain proper chair space and the headroom necessary in an upper berth. Later, a real berth (below) is installed to permit perfection of its operation before it finally takes to the air.

MORE CAR in LESS SPACE



The hood and front fenders of the Darrin are in one piece (above). Hinged at the front instead of the rear they are lifted by hydraulic power to permit motor inspection.

The Fiberglas body is unusually low, improving riding qualities. The convertible model shown carries five passengers; three in front, two in the rear. The turning radius is 20 feet.

The new Darrin saves 600 pounds by novel design.

FOR 20 years crack designer Howard Darrin engineered cars for the big manufacturers—and dreamed of producing his own. Now his dream has come true in a new superlight car of novel design, with a plastic body and hydraulically powered labor-saving gadgets.

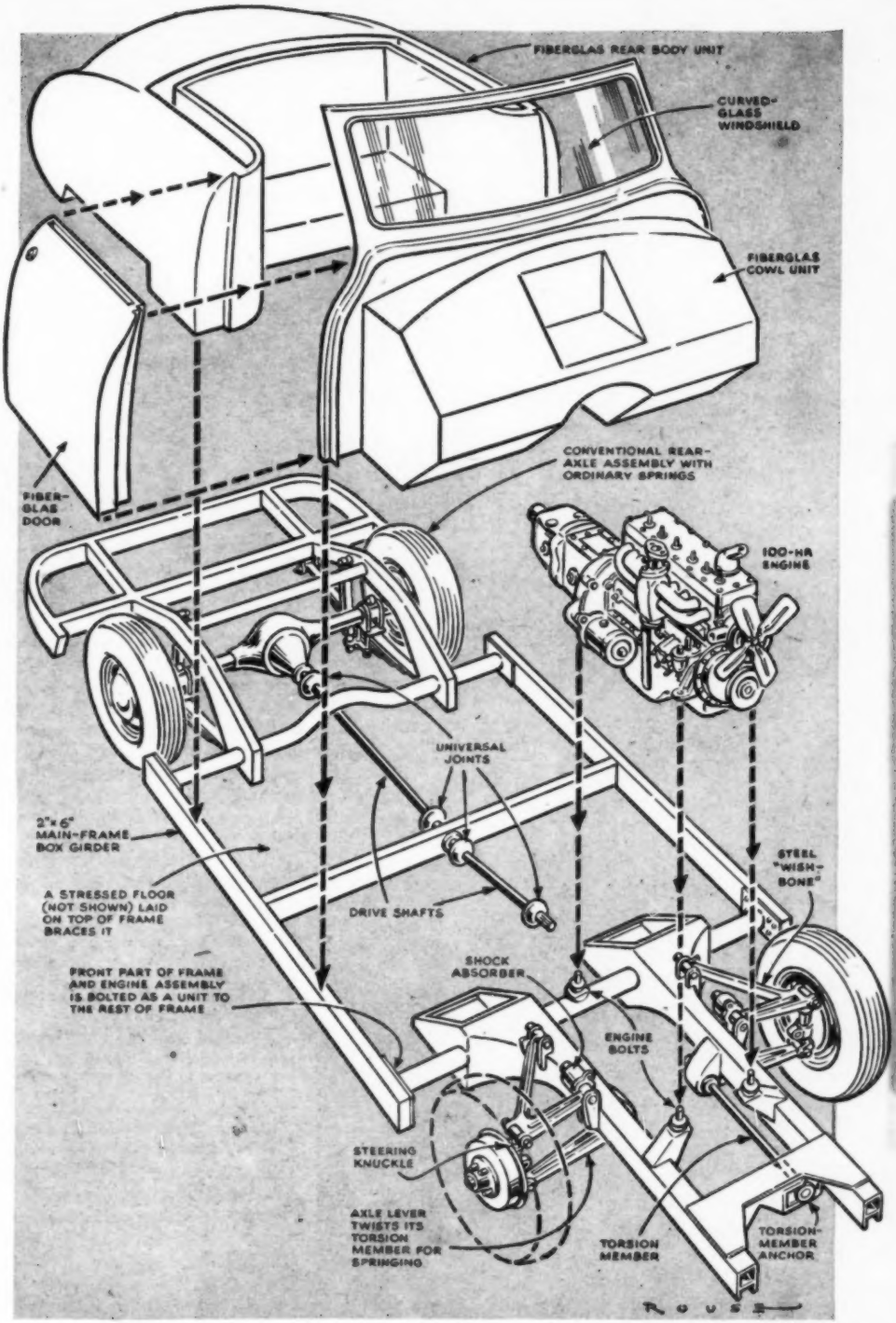
By careful design Darrin has cut the weight of his dream car from the usual 30 to 24 pounds per horsepower. Six inches trimmed from normal height and width save pounds—and gasoline—while bringing the center of gravity down to mid-axle. To permit three to sit comfortably in front, the 60-inch seat is extended to the extreme outer edge of the car. The 115-inch wheelbase carries a 185-inch body.

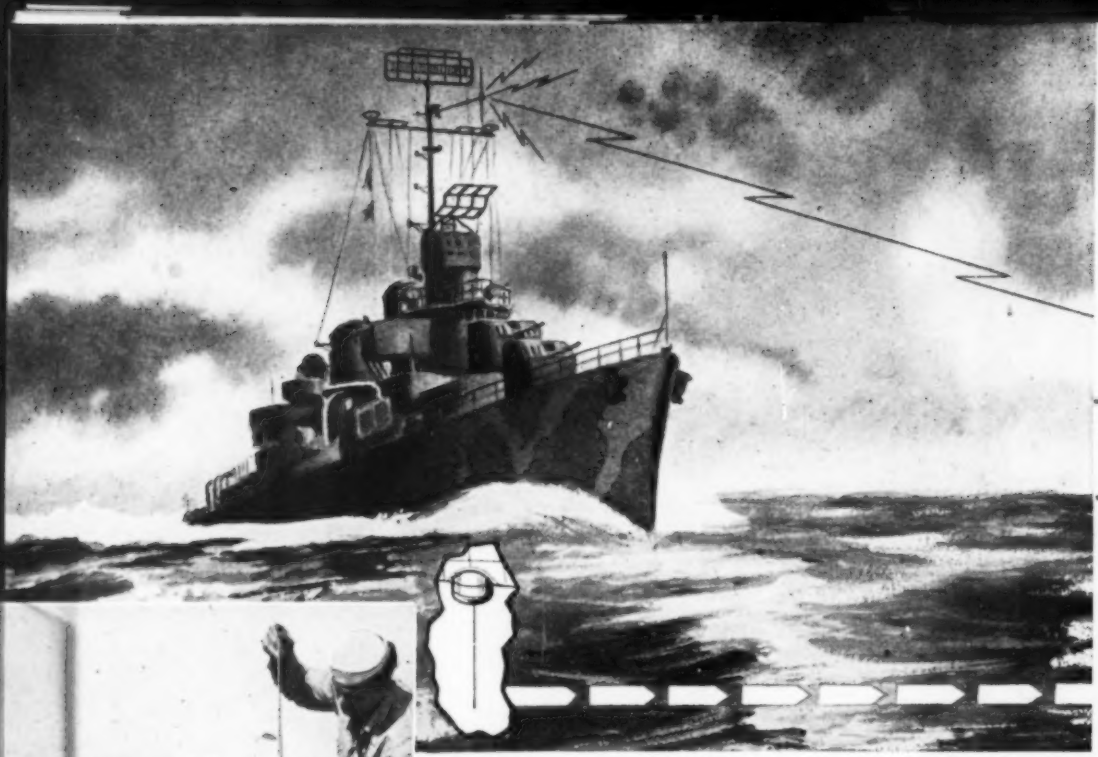
Hayes Manufacturing Company will build the body of unstressed, removable panels of Fiberglas. Four stampings are used instead of the usual 15. The curved windshield is a single unit. The chassis is rectangular, its box-section siderails, which form part of the outside structure of the car, serving as side bumpers. The front wheels are individually sprung on torsion bars with wishbone upper arms and I-beam section lower arms. In the rear, the drive is carried through semi-elliptic springs.

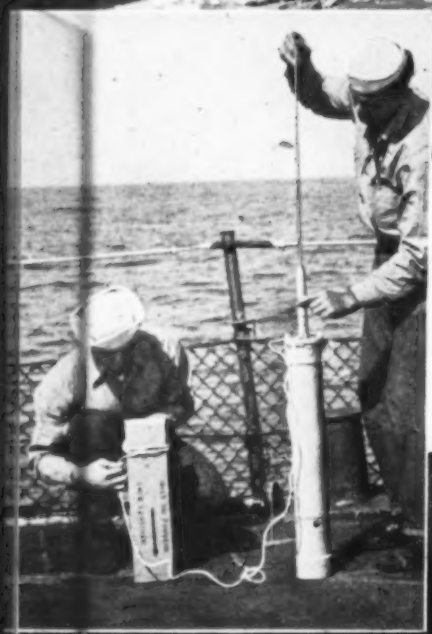
Hydraulic systems operate windows, erect top, lift hood, adjust front seat, and drop jacks to hoist the car for tire repairs.

An outstanding feature is the use of standard parts and equipment. The power package, including a 100-hp. Continental engine, is a separate assembly. An "L"-head valve arrangement is used and the pistons are aluminum.

Darrin, who designed the Kaiser-Frazier bodies and the $6,000 Darrin Packard, expects his new car to sell for less than $2,000, hopes to build 30,000 in 1947.

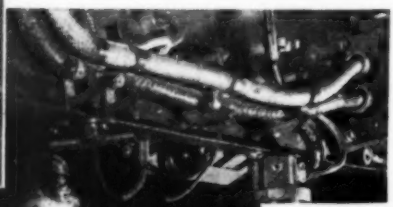

FIBERGLAS REAR BODY UNIT
CURVED-GLASS WINDSHIELD
FIBERGLAS COWL UNIT
CONVENTIONAL REAR-AXLE ASSEMBLY WITH ORDINARY SPRINGS
FIBER-GLAS DOOR
100-HP ENGINE
UNIVERSAL JOINTS
2"×6" MAIN-FRAME BOX GIRDER
A STRESSED FLOOR (NOT SHOWN) LAID ON TOP OF FRAME BRACES IT
DRIVE SHAFTS
STEEL "WISH-BONE"
SHOCK ABSORBER
FRONT PART OF FRAME AND ENGINE ASSEMBLY IS BOLTED AS A UNIT TO THE REST OF FRAME
ENGINE BOLTS
STEERING KNUCKLE
AXLE LEVER TWISTS ITS TORSION MEMBER FOR SPRINGING
TORSION MEMBER
TORSION-MEMBER ANCHOR





RADIO and sonar have teamed up to save castaways. Joined in a new Navy-developed instrument, called "raser," they enable ships or planes to find survivors of sinkings at sea despite fog, storms, or dark of night.

Raser, a contraction of Radio Sonar Echo Ranging, consists of a slender buoy carrying a hydrophone and an automatic, battery-operated, radio transmitter. The hydro-



Sailors shown at upper left are preparing to launch a raser buoy from a destroyer, in order that the crew may practice taking its bearing. Box in front of squatting sailor contains smoke-making materials to mark the buoy's position visually. At left, members of the destroyer's crew plot the direction and range of the buoy as its radio signal is picked up.

RASER to the Rescue

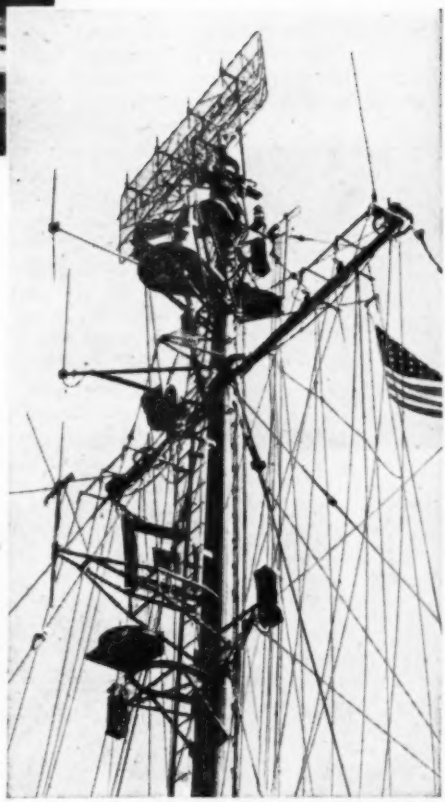
New Navy radio buoy guides sonar-equipped ships by "echo" to castaways adrift at sea.

phone, dangling 24 feet beneath the surface, picks up supersonic sonar signals (PSM, Nov. '45, p. 84) sent out by searching vessels. The transmitter then rebroadcasts the sonar "ping" as a static-free, frequency-modulated signal.

The signal is picked up by the radio of a rescuing ship, demodulated, and fed into the sonar receiver where it sounds much like the echo of a submarine.

By this means, accurate ranges and bearings may be taken on the buoy. Each sonar-equipped ship carries a pattern on transparent celluloid showing its radio antenna's ability to pick up signals from a known source while the ship is making a complete circle. When a raser signal is heard the ship is swung in a circle and the pattern of the incoming signals plotted. In a few seconds the celluloid master pattern is laid over the new pattern, which is marked in compass headings. When the two match, they show instantly the direction of the raser buoy.

The buoy is dropped overboard either from the sinking ship or plane, or from a search plane when its pilot sights the survivors. Ships can pick up the signal 10 miles away and aircraft 70 miles, while trained plotters can guide rescue craft to within 60 feet of the buoy.



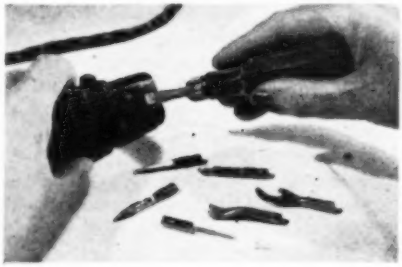
A raser buoy's radio echo of the rescue ship's sonar "ping" is picked up on a vertical dipole antenna, seen here (at upper left) projecting like a store's flagpole from the base of a destroyer's radar "bedspring" at her masthead.

AIDS TO MODERN LIVING

A SHOULDER CRADLE manufactured by H. H. Renneker, of San Diego, Calif., gives you the use of both hands while telephoning. With the cradle snugly on the shoulder, the receiver rests against the ear, and is held firmly in place, with the mouthpiece near the lips. The cradle may be installed for either left- or right-ear use and is quickly adjustable to a comfortable position.

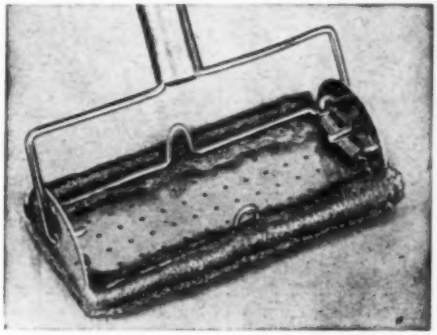
FLUORESCENT TUBES have now been adapted to a portable, self-powered light. Known commercially as "Totelite" and manufactured by Paramount Industries, Inc., of New York, the 7-lb. light operates on any standard portable B battery and gives illumination over a field of 180 deg. Measuring 4½" by 8¼" by 11", the case is made of 24-gauge cold-rolled steel with a transparent plastic shield. Control switches are under the handle.

SEVEN TOOLS come in a home kit produced by Standard Pressed Steel Co., of Jenkintown, Pa. A hollow handle, with a chuck at one end, contains a gimlet, awl, bottle opener, tack remover, punch, and standard and Phillips screwdrivers.



EXTRA STORAGE for the kitchen is provided by a rolling-door cabinet made by Mullins Manufacturing Corporation, of Warren, Ohio. Designed to fit under standard cabinets where space would otherwise be wasted, it is especially useful for keeping spices, salt and pepper, and other condiments close at hand while food is being prepared. The door, which operates like an old-fashioned roll-top desk, is made of burnished steel strips and stays open or closed without catches. Manufactured in two different widths, 18" and 24", the cabinet has two shelves.

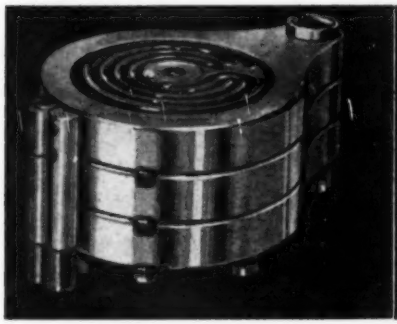
FLOOR CLEANING AND WAXING are both done with the appliance shown below. Steel wool clamped to the perforated plate is used with soap and water for linoleum, tile, wood, and other floors. Then the wool is replaced by cloth or a cellulose sponge and liquid wax is poured on the plate. The maker is Ottoson Product Co., of New York.

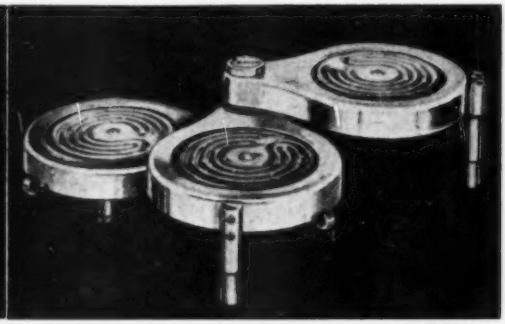


METAL PERFUME DISPENSERS produced by Bolsey Machines Corporation, of New York, lock at both the tip and refill ends to prevent leaks. Sold under the trade name of Parfumex, each dispenser holds 18 drops. Perfume is drawn out by rubbing the tip.

MEAT CAN BE TENDERIZED at home with this device, made by Ebaloy, Inc., of Rockford, Ill. It is equipped with multiple, rotating knives that sever all sinews when they are run over the surface. Construction is such that the blades will go over bones without breaking. A thumbscrew permits taking the tenderizer apart for easy cleaning after it has been used.

THREE DEGREES OF HEAT are provided by a new portable electric stove which unfolds in a cloverleaf design. If desired, the 600-watt top burner may be used alone without unfolding, as at the left below, but when the burners are swung apart three dishes can be prepared simultaneously, the 500-watt middle burner giving medium heat and the 220-watt burner low, or simmering, heat. For safety, automatic switches shut off the lower two when they are closed. Manufactured by Camco Products, Inc., of New York, the range weighs only 7 lb. and, when folded, is easily carried in a suitcase or bag.



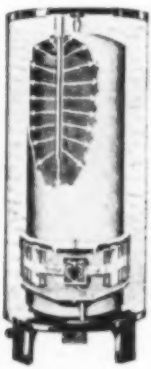


A STAINPROOF WALL COVERING has been developed by United Wallpaper, Inc., of Chicago. Tests show that almost any type of dirt spot or stain can be removed simply by washing with soap and water, while materials such as paint that are not water soluble respond to turpentine. Marketed under the name of "Varlar," it is made by fusing plastic resins and colors on paper or cloth.

Crayon sketches drawn by a child are wiped away with turpentine, and the paper is as good as new.

A GASOLINE STOVE adapted from the one used by the armed forces during the war is being manufactured by the Coleman Company, Inc., of Wichita, Kan. Standing less than 9″ high, the stove uses either white or leaded gasoline.

MOTH BALLS are kept inside the hollow arms of a new type of clothes hanger produced by the Moth-Proof Garment Hanger Company, of Corona, N. Y. As shown in the photo at the left, the balls are inserted in the ends of the arms. This gives protection to garments in steady use as well as to those put away until the next season.



HOT-WATER TANKS often are ruined by corrosion in only a few years, particularly in areas where the water supply is acid. In the new Clark electric heaters, a 24″ bar of magnesium forms with the steel and hot water a big galvanic battery, giving corrosion protection through an electrolytic action that keeps plating the inside of the tank with magnesium, as indicated by the arrows at the left. While developing this system, research workers of the McGraw Electric Company, of Chicago, discovered that the magnesium anode would be eaten away in only a few months, however. To reduce the current flow and make the magnesium last for years, the rod was insulated from its steel cap and the current flow reduced by a small resistor, as indicated in the cut-away sketch at the right. This gives protection, yet meters the flow of magnesium ions. The invention is known commercially as the Clark "Ionodic" system.

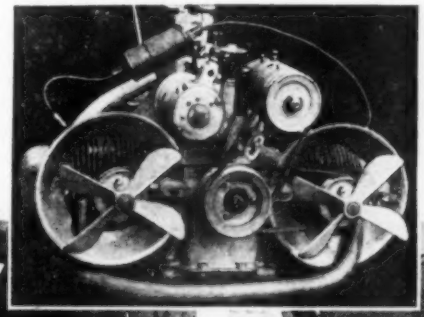
Roomy for its size, the 800-lb. French "Gregoire" is a two-door convertible sedan. Top speed is 60 m.p.h.

Aluminum Car Weighs Only 800 lb.

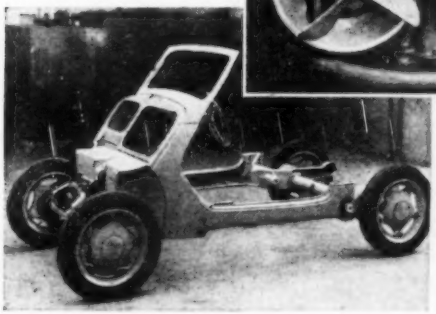
WITH a total weight of only 800 lb., this new European light car boasts a cast aluminum body, top speed of 60 m.p.h., and high fuel economy—65 miles per gal. The French "Gregoire," named after its designer, Jean Gregoire, has a convertible top, front-wheel drive, and is powered by an air-cooled, horizontal opposed two-cylinder engine.

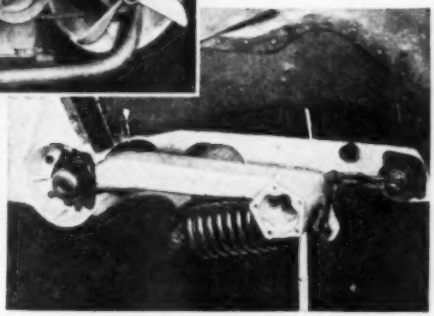
Planned in 1940, the first model was built secretly during the German occupation. Production in France is expected to be started shortly by Aluminum Francais, while American rights have been purchased by Henry Kaiser interests, which are reported planning adaptation of "Gregoire" design features to their own front-wheel drive model.

Unusually light weight is secured with cast aluminum frame (below). Wheels are simply hoop-like rims made to slip over spokes, which are an integral part of the hubs.



Horizontal opposed engine has an individual fan to cool each of the two cylinders (left). Independent rear wheel suspension uses coil springs and vane-type shock absorbers (below).





GUS Wilson Delivers a K.O.

By MARTIN BUNN

STAN HICKS rushed into the Model Garage shop, his eyes as big as brake drums. "Hey, boss!" he said breathlessly to Gus Wilson. "Jack Cross is outside in a big sporty coupe! He wants to see you!"

Gus grinned tolerantly at the grease monkey. He was a boxing fan himself, and he understood the thrill Stan got out of being spoken to by our town's only famous prize fighter.

Jack Cross never won the welterweight crown, but he came within a second of it the night 10 years ago when he had the champ stretched on the canvas and the gong clanged at the count of nine. He was still rated as a hazard any youngster had to pass before he could get a crack at the title.

"I'm going to see him fight Buzz Billings tonight," Gus said with deliberate nonchalance. "In their last scrap Buzz had him in trouble, but Jack knew too much for him and won the decision. Tell him to drive in."

"But, boss," Stan gasped. "It's Jack Cross! Hadn't you better go out?"

"Scram," Gus laughed. "I've known Jack Cross since you were in three-cornered pants."

A moment later a flashy, newly painted coupe of the late '30's was driven in, and a solidly built man climbed out and swung over to Gus with his hand extended. His face was scarred, his nose was crooked, one ear was thickened, his wide smile displayed expensive and extensive bridgework, but when he spoke his voice was surprisingly gentle.

"Hello, there, Gus," he greeted. "Haven't seen you since Napoleon was a corporal. What do you think of this jalopy I bought?"

Gus eyed the coupe. "It *was* a good car," he said, "but I can't tell if it still is."

There was a bitter note in Cross's laugh. "Like me, isn't it? Did you see me in there with Buzz Billings last month?"

"Sure," Gus told him. "I was rooting for you, but you had me worried for a while."

"*You* were worried!" the fighter said, his smile vanishing. "How do you think *I* felt? I'm fighting him again tonight, but maybe I oughtn't to. It may be time for me to quit—I don't want to end up by walking on my heels and telling people I'm training to fight Mickey Walker. Buzz hurt me with that right, Gus. I've been hearing funny noises since he smacked me with it—and I want you to tell me whether they're in this car or in my head."

Gus stared. "Trying to kid me, Jack?"

Cross shook his head. "I never felt less like kidding in my life," he said grimly.

"O. K.," Gus told him. "What's this about noises? When did you first hear them?"

"The first time I drove the car," Cross replied. "I bought it from a dealer in the city and had him recondition it."

"That proves the noises are in the car and not in your head," Gus reasoned.

"No, it doesn't," Cross disagreed. "They delivered the car the morning after the fight."

"You must know," Gus argued, "whether the car made the noises before you bought it."

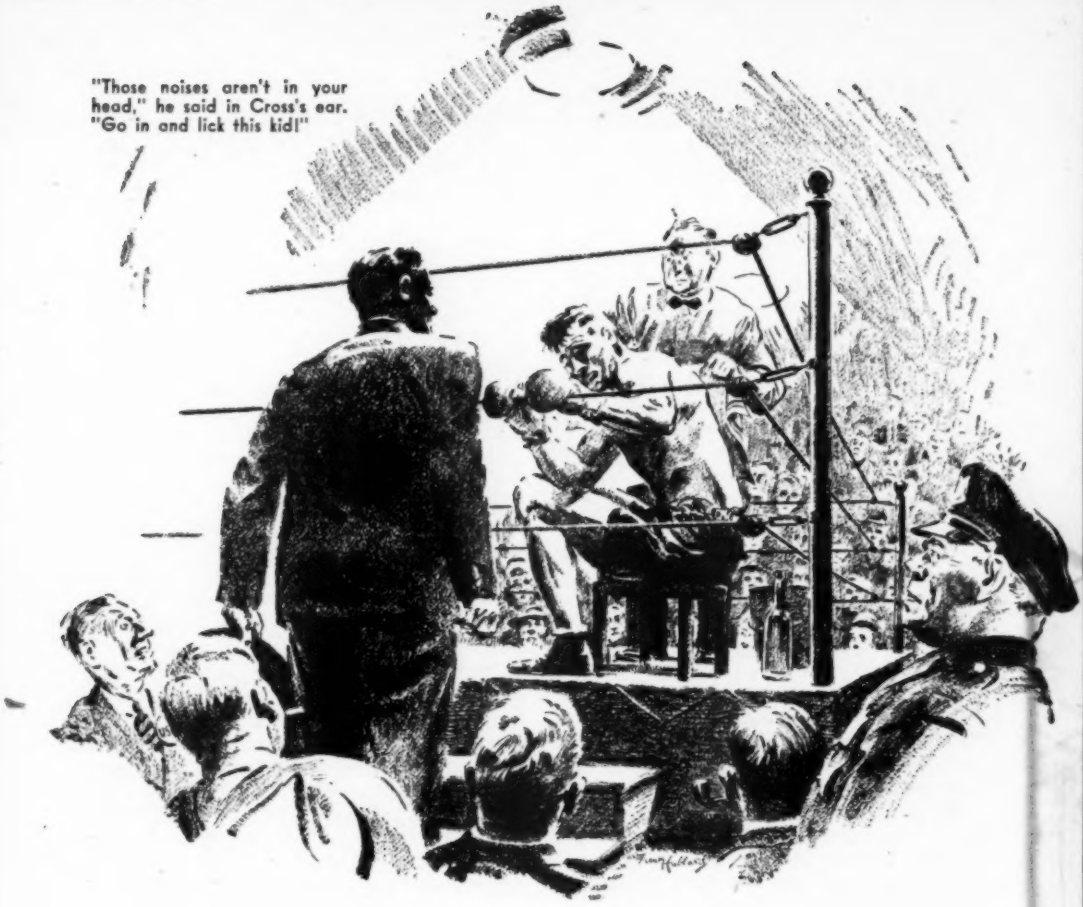
"I never drove it before I bought it," Cross admitted. "My old bus had to be junked, and I took the salesman's word that this one would be thoroughly reconditioned. The morning after the fight I wanted a vacation. I phoned the dealer to send the car around to the hotel, and I started to drive it down to Atlantic City. In about a block I began to hear the noise—a sort of low *tick-tick-tick*. When I got out on the road and speeded up it got louder, and the ticks began to come closer together until the noise was pretty near continuous."

"What did you do?" Gus asked.

"After I had listened to the noise for about an hour," the boxer told him, "it began to get on my nerves, so I stopped at a garage. The mechanic said that the speedometer cable was shot and put in a new one. But I heard the noise again as soon as I got out on the road. I stopped at another garage. That fellow said it was caused by a wheel bearing and spent an hour putting in a new one. But the noise got louder and louder, and after I'd gotten to Atlantic City and checked in at the hotel I kept on hearing it—all night."

"I've had the same thing happen to me," Gus put in. "Just nerves."

"You think so?" Cross asked. "Listen to the rest of it. Next day I took my bus to a big repair shop. I got it back in two days with a big bill and a song and dance about the transmission—and the tick was still there.



"Those noises aren't in your head," he said in Cross's ear. "Go in and lick this kid!"

Driving back from Atlantic City, it sounded sometimes as if it was in one part of the car and sometimes in another, and after an hour I was sure it was in my head. When I got to the city I took the car to the place I'd bought it. The manager drove with me for a block and said I was imagining things."

Gus scowled.

"I was so scared I couldn't say anything," Cross went on. "Since then I've kept on hearing the noise—in the car and out of it—but I haven't told anyone but you. Maybe I shouldn't fight Buzz again—they're building the kid up and figure he'll kayo me. You know your business, Gus, and I know you're on the level. Locate that noise and cure it, and I'll know I'm all right. If you say there's no noise, I'll know I've taken too many punches."

"That's easy to decide," Gus told him. "Hop in, and we'll take a ride."

Cross looked at the shop clock. "I can't—I've got to get down to the city," he said. "My manager's waiting outside. Keep the car, and I'll be in tomorrow. Coming to the scrap tonight? Win or lose, it'll be my last. I'd like to wind up with a win, but I'm not going to give Buzz a chance to nail me with that right again—not with me hearing funny noises in my head!"

"Sure, I'm going to the fight," Gus laughed. "And forget the noises. I'll prove they're in the car and not in your head."

AFTER Cross had hurried out, Gus jumped into the coupe and headed up the highway. He heard the noise at once—a well-spaced *tick-tick-tick* that grew louder when he increased speed and became a fast, loud buzz when he worked it up to 50. At first it sounded as if it came from the transmission, then from the rear end, then from the front wheels.

"The noise is there, just the way Jack

heard it," he told Stan when he got back. "But finding the cause may take quite a while. If I could tell Jack what it is before he goes into the ring it would ease his mind and maybe help him win. Let's get busy!"

Working quickly but carefully, he checked and rechecked—but after an hour the source of the noise still was unfound.

"We're not getting anywhere," Gus said. He lighted his pipe and blew clouds of gray-blue smoke as he stared at the coupe and dug into his memory for the cause of each mysterious car noise he'd had to run down.

"That *could* be it," he muttered after five minutes of concentration. "It *must* be it. . . . Hey, Stan—forget your dinner and help me pull off this torque-tube assembly."

It was a long job, but when it was finished Gus grinned with satisfaction.

"There's what made Jack Cross think he was going nuts," he told Stan, pointing to the taper pin which in that car holds the drive shaft to the driving pinion in the rear end. "The pin is driven tight at the factory but sometimes works loose the way this one did. It can't drop out because of the torque tube, so the shaft still drives the gear, but the rotating pin strikes the tube and makes a ticking noise that is so hard to locate that most mechanics miss it."

He pulled out the loose pin, examined the taper hole in which it had been seated, and checked the torque tube.

"That's good," he told Stan. "The hole hasn't worn, so all we have to do is drive the pin back good and hard. Sometimes a pin cuts a groove so deep you have to install a new tube."

"I get you—I guess," the youth muttered.

Gus climbed into his own old roadster. "Jump in," he called to Stan. "I'll buy you a ticket to the fight."

BUT they had worked so long, the Cross-Billings bout had gone six rounds by the time they reached the arena.

"How's it going?" Gus asked the man next to him as the gong sounded for the seventh.

"Billings all the way," he was told. "Cross seems to be washed up."

Gus watched as Cross came out of his corner. He was brisk enough but painfully cautious, constantly circling to his right in an obvious attempt to keep out of range of his opponent's Sunday punch. Billings, confidently aggressive, snapped the veteran's head back with stinging left jabs.

It was that way all through the seventh and eighth rounds. Only Gus knew that Cross was worried sick by fear of becoming punch drunk.

"If I could only tell him!" Gus muttered.

In the ninth, he could stand it no longer and began to work his way toward the ring. An usher ordered him back, but he kept going. He got to Cross's corner as the round ended. A cop grabbed at him and missed.

"Jack!" he yelled. "I've got to talk to you!"

Cross, sitting dejectedly on his stool, recognized his voice above the roar. He turned, saw Gus, and said something to a second, who beckoned. Gus climbed the ring steps.

"Those noises aren't in your head," he said in Cross's ear. "They're in your car—a loose pin. That's on the level, Jack. You aren't getting punchy. Forget it—and go in and lick this kid!"

The veteran's cut lips twisted in a grin, and he managed a wink with a puffed eye.

"Thanks, Gus," he muttered. "Watch me."

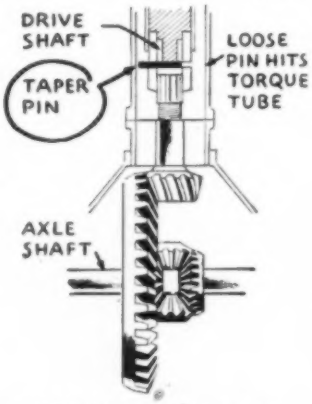
The gong clanged. They met in mid-ring and touched gloves in the traditional final-round handshake. Then, his right cocked and his extended left ready, Buzz glided forward, expecting to tag Cross with another jab as he circled away from his right. But this time Jack didn't circle. He stood firm. His left flashed out, and his glove smacked into the pit of his opponent's stomach.

Buzz gasped, and he doubled over and tried to wrap his arms around Cross. But Jack slid back—then forward again—and let go his right. The punch landed on the side of Buzz's jaw. His knees buckled, and he pitched forward on his face.

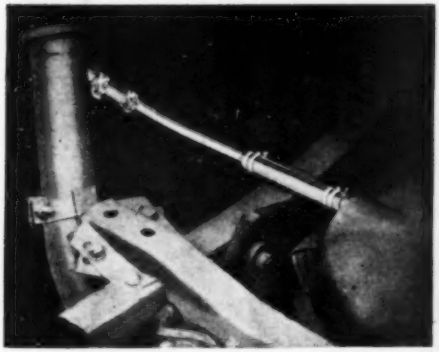
The referee's arm rose and fell with the count. ". . . eight . . . nine . . . ten!" He grabbed Jack's right hand and held it up. "The winnah—Jack Cross!"

Jack grinned crookedly at Gus. "I get the credit, but you won the fight."

"O. K.," Gus said. "I'll put it on the bill."



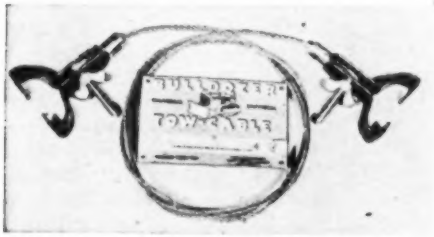
The pin is driven tight at the factory but sometimes works loose.



AUTO IDEAS

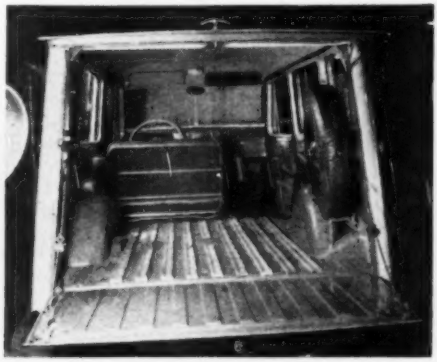
PREVENTION OF GAS LOSS through spilling and evaporation when the tank is being filled is the object of an air-pressure relief pipe leading from the tank to the filler pipe on the new 1947 Studebakers. The relief pipe releases air that would otherwise cause the gasoline to foam and gurgle as the level rises in the tank. It was designed after a study of waste from this cause.

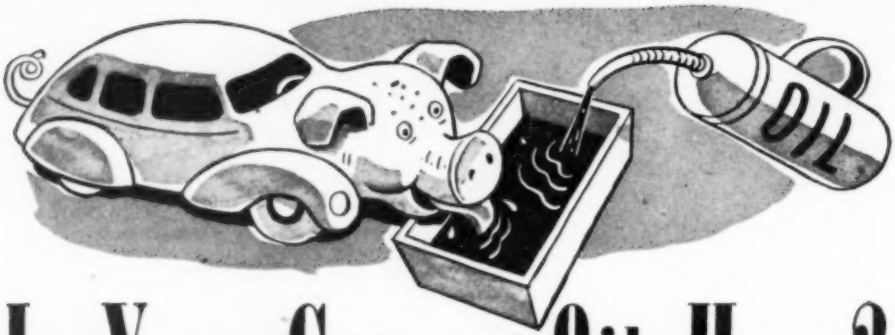
RIGHT AND LEFT TURNS are signaled by an arrow that lights up on the back of the car when the driver flicks a switch attached to the steering post or on the instrument board. The accessory is manufactured by the U. S. Metal Products Co., of Brooklyn, N. Y.



NEW LIGHTWEIGHT TOW CABLES are equipped with clamping jaws that can be attached to the bumper simply by tightening a wing nut. A woman can easily put one on. The cables are galvanized as a protection against rust and come in three sizes, with minimum breaking strength of about 2,000 lb. for the smallest size. They are a product of the Wind Turbine Company, of West Chester, Pa.

JEEP STATION WAGONS have joined the Willys-Overland procession of jeeps revamped for civilian uses. This model has an all-steel body, the 63-hp. jeep engine, and a new chassis and running gear. The body is finished to resemble mahogany and maple, but the only wood used in construction is maple for floor runners to facilitate loading and unloading. Removable, waterproof seats will carry six riders besides the driver. The interior can be hosed clean.





Is Your Car an Oil Hog?

OIL costs money, and no one wants to waste it, but many of the war-weary cars now on our highways consume it like a fuel. If your car is in this oil-hungry class, it's a pretty safe bet that your rings, pistons, bearings, or valves are faulty, or you go too fast for the age of the car. But even if you should pay out good money for a ring job, you might discover later that you need as much oil as before. How this can happen is intricately involved with the many reasons for high oil consumption.

Oil is not simply a lubricant, as many persons think. Automotive engineers have determined that about nine tenths of its job consists of helping keep the engine cool. Reduction of friction is only one tenth.

This heat-removal function helps explain high oil consumption. When an engine heats up because of high operating speed, abnormal atmospheric temperatures, or a dirty cooling system, a heavier burden is thrust upon the oil. Heat thins all oils. Consequently, in old engines with loose bearings, more oil is thrown to the pistons. If these are loose and the rings worn, oil gets by and burns in the cylinders. Loose intake-valve stems and clogged rings also cost oil.

The relationship betwen speed and the amount of oil consumed was demonstrated a few years ago. Several cars were driven a certain distance at 30 m.p.h. Then the same cars were driven the same distance at 55 m.p.h. At the higher speed, the oil consumed by the individual cars was 2½ to 19 times greater than at the lower speed, the average being *seven times greater.*

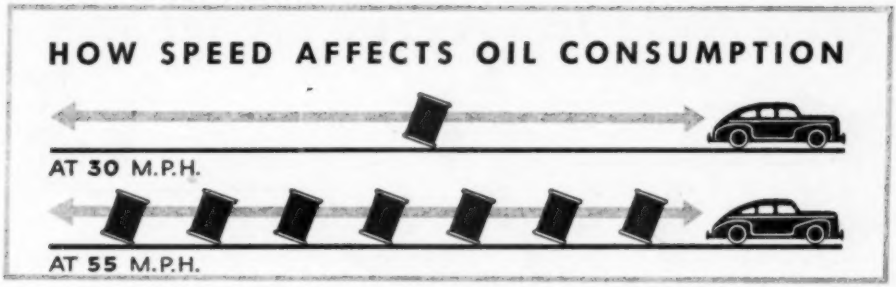
In the case of the car that consumed oil at a rate 19 times faster, it's simple to see how a driver, accustomed to the car's low-speed oil consumption, could burn out a bearing in short order. There are two very simple precautions that you can take to prevent such damage. Check the crankcase oil level every time you buy gasoline, or more often if you are driving far and fast, and keep a watch on the oil-pressure gauge.

In a memorandum issued to its dealers, the Socony-Vacuum company lists the mechanical condition of the engine, driving speed, operating temperatures, and the type and grade of oil as the major factors controlling the rate of oil consumption. The memorandum observed that poor mechanical condition of engines has caused a large increase in oil use since the war ended.

In old cars, oil is apt to be wastefully burned in the combustion chamber. If oil-control rings or drain-back holes in the piston are clogged, the rings will allow oil to pass into the chamber instead of forcing it back to the crankcase. If rings are worn, sluggish, or stuck, they will not carry out their job of sealing off the combustion zone from the crankcase region; as a result, the suction stroke will carry oil into the combustion chamber and hot blow-by gases will rush down the cylinder walls on the return stroke, contaminating the crankcase oil.

Motorists sometimes have noticed that their oil consumption is reasonable up to a certain speed while beyond that their cars become the worst type of oil hog. When such a condition occurs, the compression and oil rings usually have lost part of their wall pressure. At low speeds, this makes little difference, but when the engine operates faster the rings bounce, or "flutter" as the ring makers say, allowing oil to get into the compression chamber.

A similar oil waste may result from collapsed piston skirts, worn intake and exhaust valves, worn valve guides, and worn, scored, scuffed, or distorted cylinder walls.



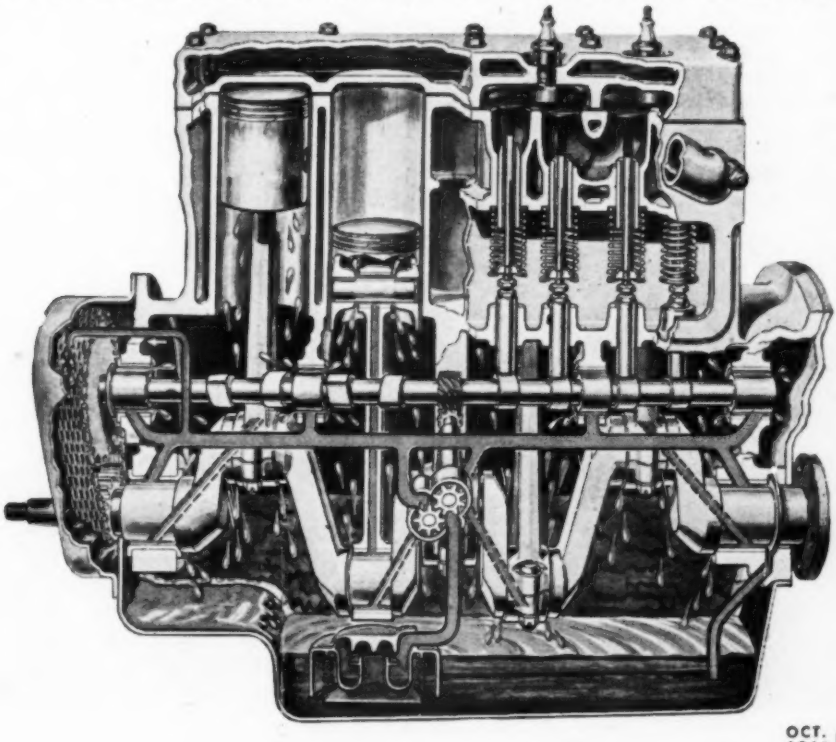
In actual tests, the same cars used seven times as much oil at a 55-m.p.h. average as they did at 30 m.p.h.

No one would blame you for complaining if your car should use as much, or more, oil after an overhaul. But this has happened, and the explanation is simple. Unless the mechanic exercises care, the act of tightening a cylinder head can distort the engine block sufficiently to force the cylinders out-of-round so the rings cannot form a seal.

Cylinder heads should be installed with strict attention to the manufacturer's instructions. This entails not only the tightening of hold-down bolts in a definite order, but pulling them down a definite amount with a torque wrench.

Unsatisfactory results also may follow a ring overhaul unless the entire lubricating system is properly balanced. The oil pump is the key to distribution of the correct amount of oil to each vital bearing surface of an engine. A faulty pump or clogged screen may starve the bearings and cylinders. When the main bearings become worn,

In modern cars, oil flows through a complicated system. For oil economy, each part must work properly.



FIVE WAYS TO PREVENT OIL TROUBLE

1 Don't drive an old car at the speed it was capable of when new. Wear in the engine parts of such a car shows up promptly in its oil demands at high speeds.

3 Carrying a spare can of oil in your car is good insurance against a burned bearing or other costly trouble. The few extra miles when you run out of oil in an isolated spot could do the damage before you reach a gas station.

4 Check the oil each time you get gas. Use the grade and type recommended for your car.

2 Train yourself to observe the oil-pressure gauge at frequent intervals while you are driving. If the pressure drops off, stop at once and check the oil.

5 Make the exhaust-pipe test with your finger. If the pipe has oily deposits, the rings, pistons, or valves need attention. If it is clean and dry, any oil loss may be due to leaks.

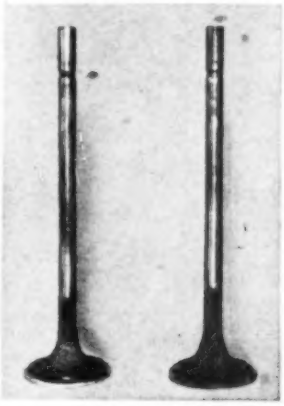
oil leaks away there and the bearings in the connecting rods may suffer. When these are worn, excess oil floods the cylinders, the oil control rings cannot function properly, and much of the excess oil finds its way quickly into the combustion chamber.

Leaks to the ground account for a heavy loss of oil. It has been computed that one drop spattered on the highway each 100′ will add up to a full quart of oil in 200 miles. Leaks may occur around loose or worn gaskets, faulty threads on an oil drain plug, a loose drain plug, a damaged fuel-pump diaphragm, or through internal or external cracks.

While every autoist knows that the crankcase oil should be kept at the prescribed level, the reasons why are less well known. If it is low, a smaller volume is available to dissipate engine heat, oxidation occurs faster, and sludge or varnish deposits build up more quickly. Too much oil also is bad economy. In that case, the oil, churned by the crankshaft and connecting rods, overloads the rings to such an extent that they can not limit the amount reaching the upper cylinder zone. It also is important that you use oil of the grade recommended for your car. Oils with too heavy a body are more difficult to circulate and consequently raise the temperature. Those that are too light will not perform the tasks of lubrication and heat removal they are supposed to do, and are more apt to be lost through leakage.

You'd hardly expect to have oil economy if your pistons are in the condition of the one at the left. It indicates what happens when the rings become stuck.

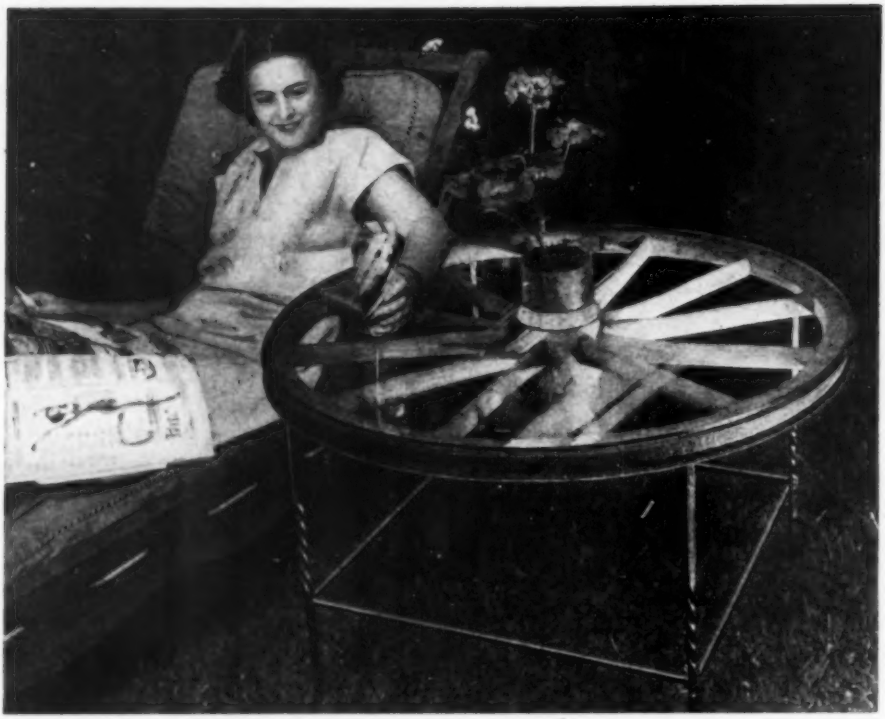
Carbon deposits are evident on these valves, while their shiny stems suggest wear in the valve guides. Such a condition wastes oil in the combustion chamber.



Photos courtesy of Socony-Vacuum

MECHANICS AND HANDICRAFT

- 100,000-Volt Static Generator
- Furniture from Wagon Wheels
- Sky Climber...A Rubber-Band Model
- Indicating Inside Calipers
- Midget Code Transmitter

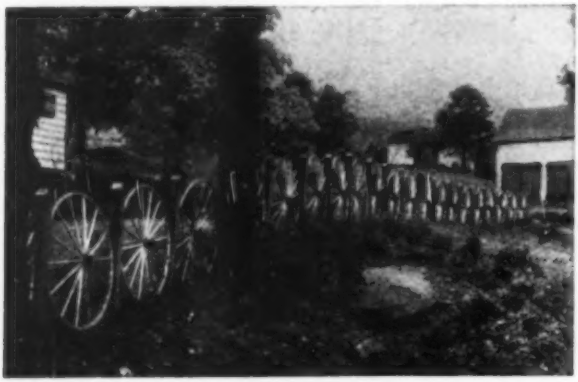


Turn Wagon Wheels to Profit

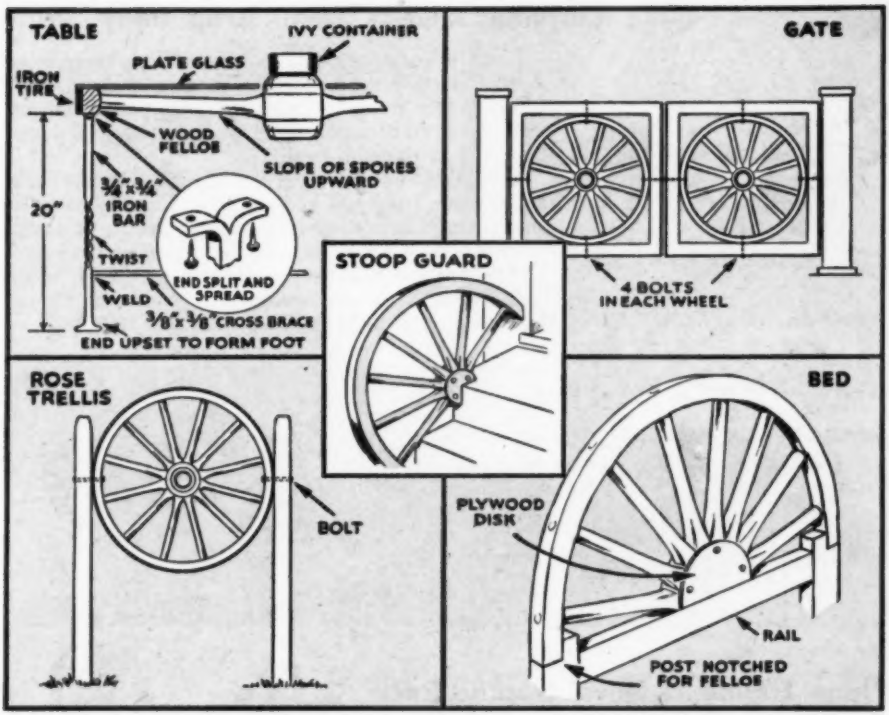
IF YOU have or can get some wagon wheels, there are a whole wagonload of uses to which you can turn them. Although such wheels are fast entering the limbo of the bustle and the whale-oil lamp, they can still be found in farm yards, old stables, and junk yards. Made by master craftsmen, and often out of choice woods, they would be costly to duplicate. Many are of graceful and pleasing proportions.

Shown in the accompanying illustrations are only a few of the interesting things that can be made from wagon wheels. Paint may be removed, and wax or varnish applied to bring out the natural color of the wood, or gay colors may be used.

The table shown has a round glass top with a hole for the hub cut to order by a glazier. The center hole adds to the cost of the glass, and can be avoided if the hub



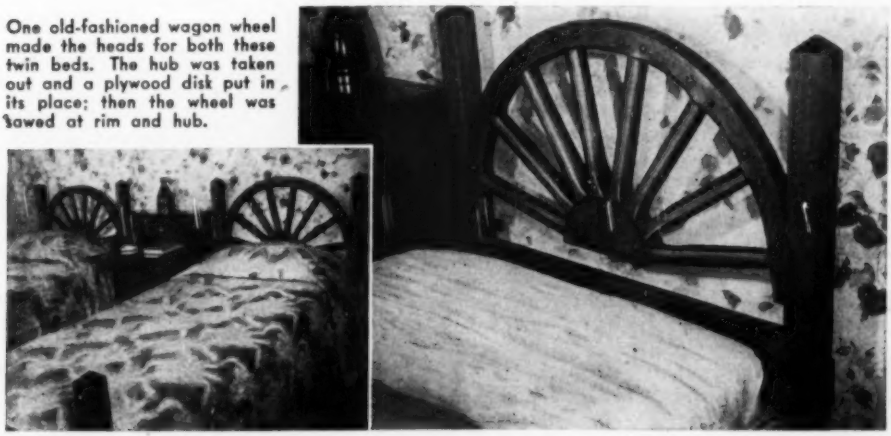
Wagon wheels bolted between posts make a fence that will become a rustic landmark.



is unbolted and removed. A plywood disk can then be nailed in to replace it, as on the heads of the beds shown. Fit the glass to the outer edge of the tire unless the felloe is recessed, in which case it should fit inside the tire.

Wheels are bolted between posts for trellises and fences and in frames for a gate. One long bolt may hold two wheels to a fence post betwen them, but it may be easier to bolt one wheel at a time and use another bolt higher or lower for the second wheel. A quarter segment is sawed out of the stoop handrail.—Eric Sloane.

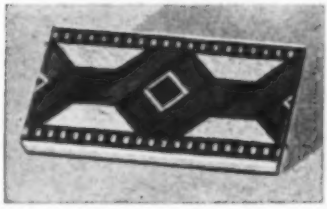
One old-fashioned wagon wheel made the heads for both these twin beds. The hub was taken out and a plywood disk put in its place; then the wheel was sawed at rim and hub.

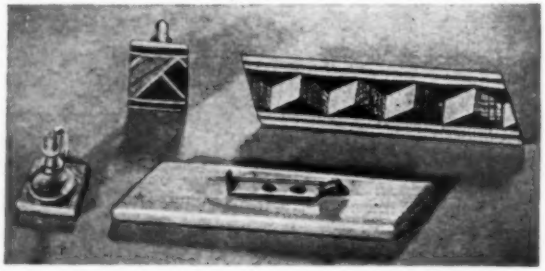


Costume Jewelry from Scrap Inlay Strips

HERE is something you can do with leftover inlay strips and make a hit with the women in your family. Glued to thin wood and equipped with pins or earring clips, the strips become bright costume jewelry, as shown here and in color on page 112.

Discarded Venetian-blind slats were used for the backing of these lapel pins and earrings. Glue the inlay on the backing, cut to size, and sand and varnish. Fasteners can be held to the wood with household or model-airplane cement if the metal is cleaned thoroughly of oil and grease. It is not necessary to sand paint off the backing stock to make it adhere.—GEORGE R. JONES.





Plane Engine Is Novel Necktie Rack

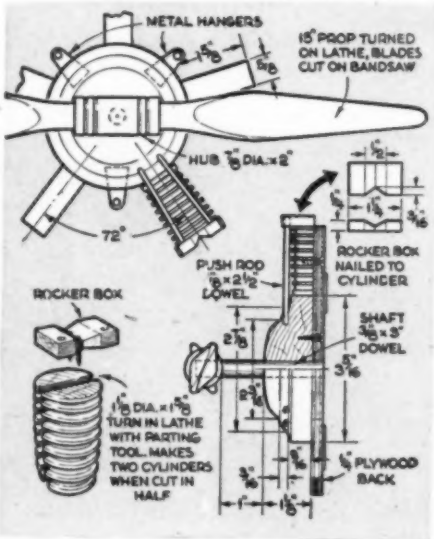
AIRCRAFT enthusiasts who also like to make things of wood will enjoy working on this novelty tie rack. Six to eight neckties can be kept in full display on the propeller blades, or more if you don't mind thumbing through in making selections.

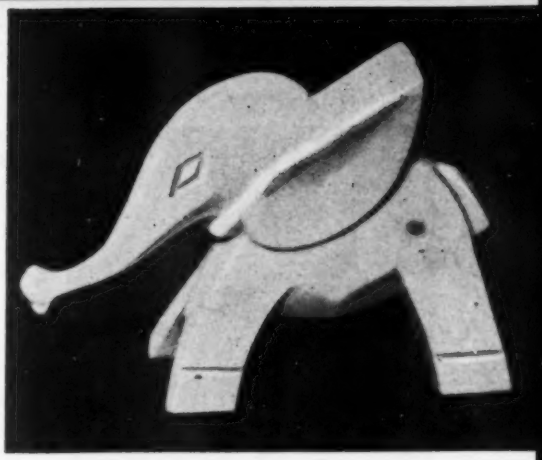
Turn the crankcase on the lathe faceplate, saw out of ¼" plywood a backing piece having five equally spaced ⅝" by 1⅝" arms, and assemble with screws. The five cylinders can be turned from 1⅛" dowel and the fins made with a parting tool. Only three need be turned, for each will make two cylinders for the project when cut in half.

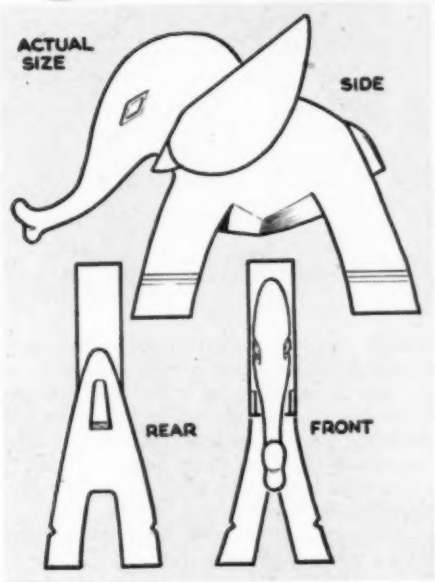
If ⅜" dowels for the push rods are not available at a model-supply house, lollipop sticks can be substituted. Assemble the cylinders, rods, and rocker boxes on the crankcase and back with glue, screws, and brads.

The propeller blades and hub are turned as one piece with a maximum diameter of 1⅝" at the wide part of the blades. Flatten the blades on a bandsaw or by carving and mount with glue on a ⅜" dowel shaft. A small block glued behind the tip of each blade will keep ties from sliding off.

Finish the engine and shaft black and the prop with aluminum paint.—JOE ZEBROWSKI.







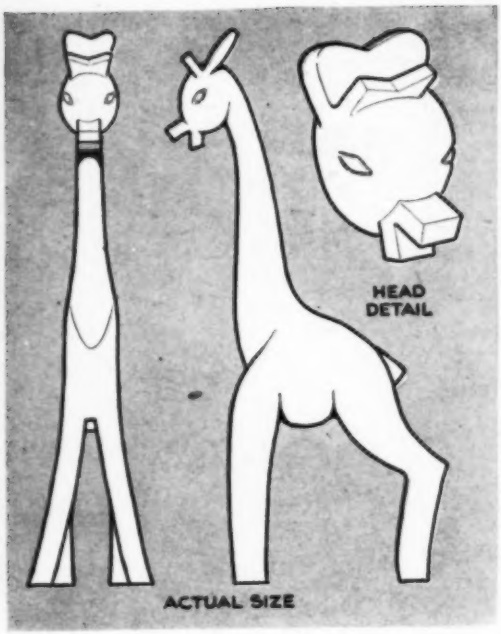
By JUEL F. ALSTAD

ONE of the simplest and least demanding materials for carving is common hand soap. It's cheap, too—scraps whittled from a bar can be saved and used for washing clothes and dishes, and the carving itself, if it should be ruined by a slip of the knife, is still useful in the bathroom. Of course, if you turn out a masterpiece, you may want to preserve the carving as a mantel ornament.

Among the pieces that can be carved after a little practice are ivorylike statuettes, toy zoo animals, Christmas-tree ornaments, novel place cards, and personalized gifts and souvenirs. Silhouettes and cameos that turn out well can be attached to tin foil or paper backing with water glass (sodium silicate) and hung like plaques. Pieces may be colored with poster or other water colors, but don't brush so hard that the soap lathers.

Rectangular white bars that are fresh and evenly soft-textured are best. Two or more

Lay a paper pattern on a bar of soap and trace the figure with an orange stick; then pare off the excess, working toward you, to rough the piece to shape. Curves are scraped smooth with the edge of the knife.

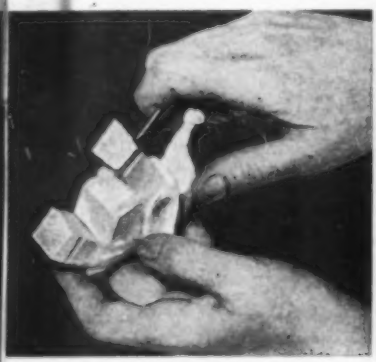


may be joined for a large carving by soaking the sides until they soften and pressing them firmly together. It is wisest to begin with small figures until you get the knack.

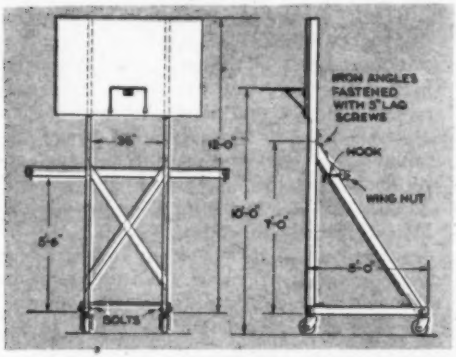
A paring knife or jackknife will do all the carving. Draw the figure on paper and trace it on one side of the bar with an orange stick or a blunt pencil. No carbon is used. Rough the figure to shape by paring, making the piece generously large for finish shaping. Then scrape it down to final shape and size with the edge of the knife. Nicks may be worked out by using the blade flat, and gouges filled by fitting in wetted pieces.

Carve by working the knife toward you to avoid breaking off projecting parts. Unlike whittling wood, it is best to finish one side and match the other to it. Separations such as between legs can be made by working the point of the knife down gently. Slender portions are rounded with the point. Finish with a moistened cloth, rubbing the whole figure gently to give it a sheen and work out nicked spots.

Separations between the legs are made by pressing the knife point down gently. Nicks and ridges can be smoothed with a moist cloth. Two or more cakes may be soaked and pressed together for large carvings.



Basketball Backboard Won't Mar Garage

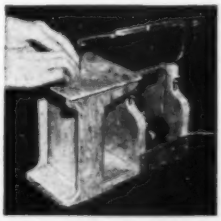


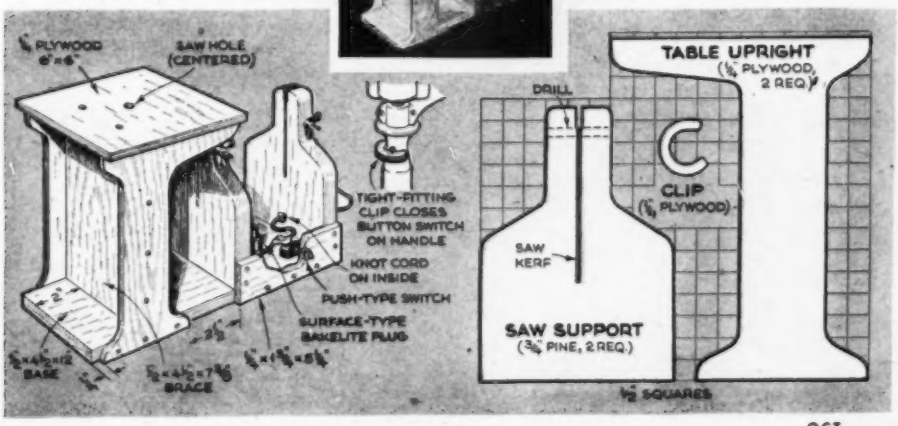
INSTALLING a basketball backboard for the kids frequently means a compromise between utility and preserving the appearance of your property. This one, on a demountable frame equipped with large casters, adds the driveway to the playing area. The crossbar should clear players' heads.—E. A. RERUCHA.

Table Stand Adds Accuracy to Vibrating Electric Coping Saw

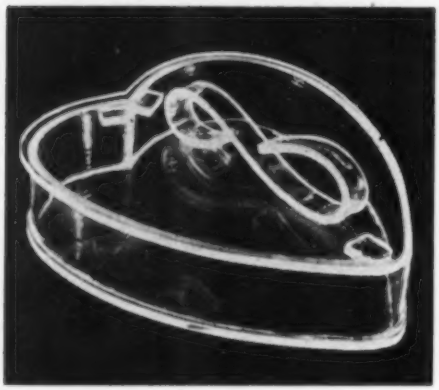
CRAFTSMEN who use a vibrating electric coping saw sometimes find the vibration transmitted to small work when the saw is held by hand. A table and stand will improve the accuracy of fine cuts in model-making, jewelry work, and the like. By loosening the wing nuts the saw is quickly removed when needed as a hand tool.

Make the base, the saw supports, and brace of pine, and the table and other parts of plywood. The supports are notched 3/64" wide by ½" deep to receive the saw frame, and the notch is extended downward about 3½" with a single saw kerf to permit some take-up that will clamp the saw tightly. A ¼" saw hole in the table should allow blade movement without binding when pressure is applied in operation. Make sure the table is square with the supports. Assemble with glue and with countersunk screws.—JOHN J. GALLIVAN.



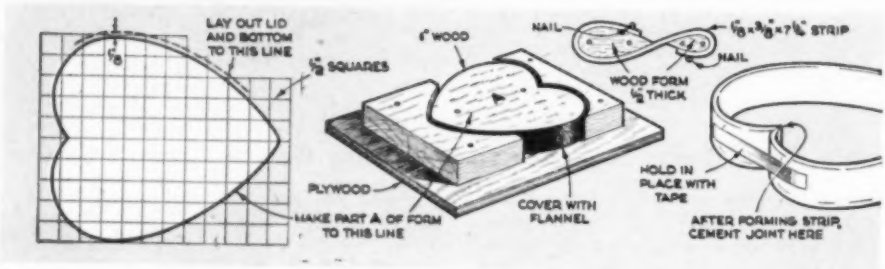


Heart-Shaped Plastic Jewel Case Shows Contents at a Glance



CLEAR, crystal-like plastic has a sparkle that makes it ideal for a jewel case. Saw the top and bottom of the box to shape with a jigsaw or coping saw and file or sand the edges. The side and handle are heated one at a time in an ordinary oven for three minutes at a temperature of 220 deg. or till quite pliable, removed with gloved hands, and bent to shape. A simple jig will help in forming the side.

Cement the ends of the side together and tape until the cement sets, and then cement the side to the bottom. File flats on the handle and cement it. Put the top in place, mark for stops with a glass-marking crayon, and cement them on.—JOHN A. VINCENTI.

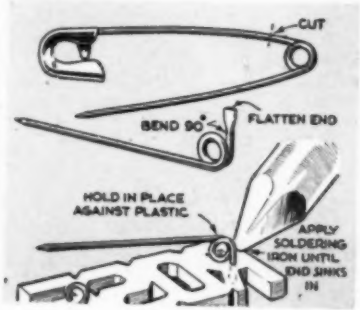


Jigsawed Plastic Lapel Pins Bear Girls' Names in Script

SCRAP pieces of clear plastic about ⅛" thick, some masking tape, and a jigsaw can be the means of turning out personalized, ornamental pins to delight feminine hearts.

Tape both sides of the plastic and write the name on one side in full, rounded letters. Drill 1/32" holes where necessary for interior cuts, as at top left in the photo, and make the inside cuts first, as at the bottom left. Use a .020" thick, .070" wide, 32-tooth metal-cutting blade. This is important because coarser blades chip the material, thinner blades break, and wider ones will not turn in their own radius. If your jigsaw has variable speeds, run it at about 1,400 r.p.m.

Remove the tape and attach the pin to the back. A safety pin with part of the back cut away serves. Flatten the short end, hold with pliers, and touch the loop with a hot soldering iron.—J. DOUGLAS BATES.

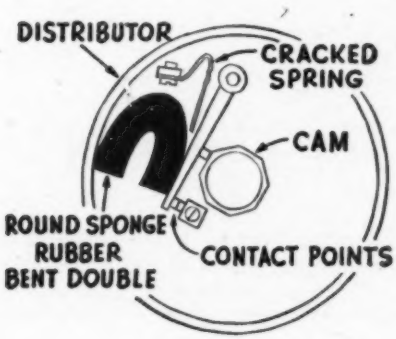


WHAT'S YOUR INGENUITY QUOTIENT? IQ

Have you pulled off a smart one lately? We will pay for each contribution accepted for this page showing ingenious solutions of problems in the home, shop, garage, or camp. It doesn't matter if it's wacky—if it works.

BEING NO BABY, I found crawling around on the grass to give my lawn a close shave was hard on my back. I couldn't find a pair of extension clippers, but made my short ones do by bolting them to a frame with a link action to work the blades. It's what some people might call going to grass the easy way.—C. A. VEBURG.

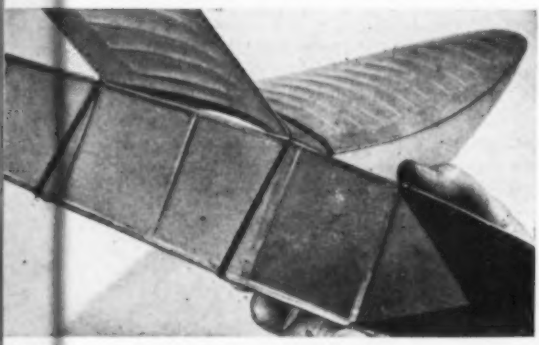
CONTACT! Pilots used to get results with that word, but when I shouted it, the cracked spring in my distributor paid no attention. Since it was 1 A.M. and a long way from home, I tried substituting a piece of rubber for the jinxed spring. The points closed, and away we went.—G. R. RUEL.



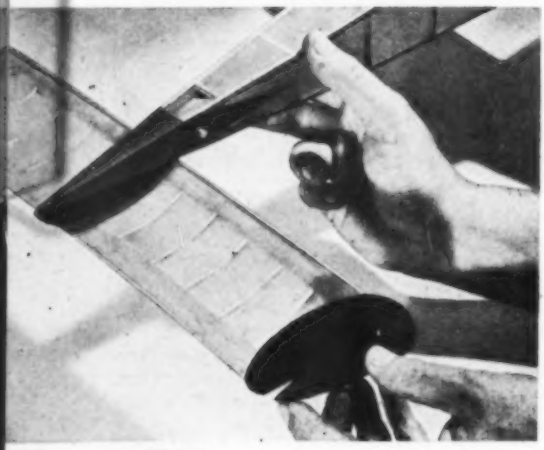
A LIGHT PURSE can mean you're broke, or that you've had a brainstorm. With me it's the latter, for I'm all aglow with the bright idea of stitching loops in my pocketbook to hold a small, flat flashlight. With the switch located near the clasp, I can open the pocketbook and flip on the light in one easy motion. Whether I'm looking for powder or pennies, this is one woman's purse that holds no secrets.—MARY JANE COCO.

AIR RAIDS DIDN'T END for me when the War stopped. An air force of flies and mosquitos kept me alerted for many nights. These boudoir bombardiers hardly light long enough to be swatted, so I dropped my swatter for a vacuum cleaner. The extension tube sucks 'em in like a drain does water. Now it's just a few minutes between "Attack" and "All Clear," and my walls stay clean.—WALLACE N. BROWN.

A folding prop cuts wind resistance and gives the model a smoother glide when the power runs down.



Both wing and stabilizer have a deep undercamber, as you will notice above and below. A slit in each rudder allows for warping to make the model turn.



SKY CLIMBER

....A High Flying Rubber-Powered Model

By PAUL MUELLER

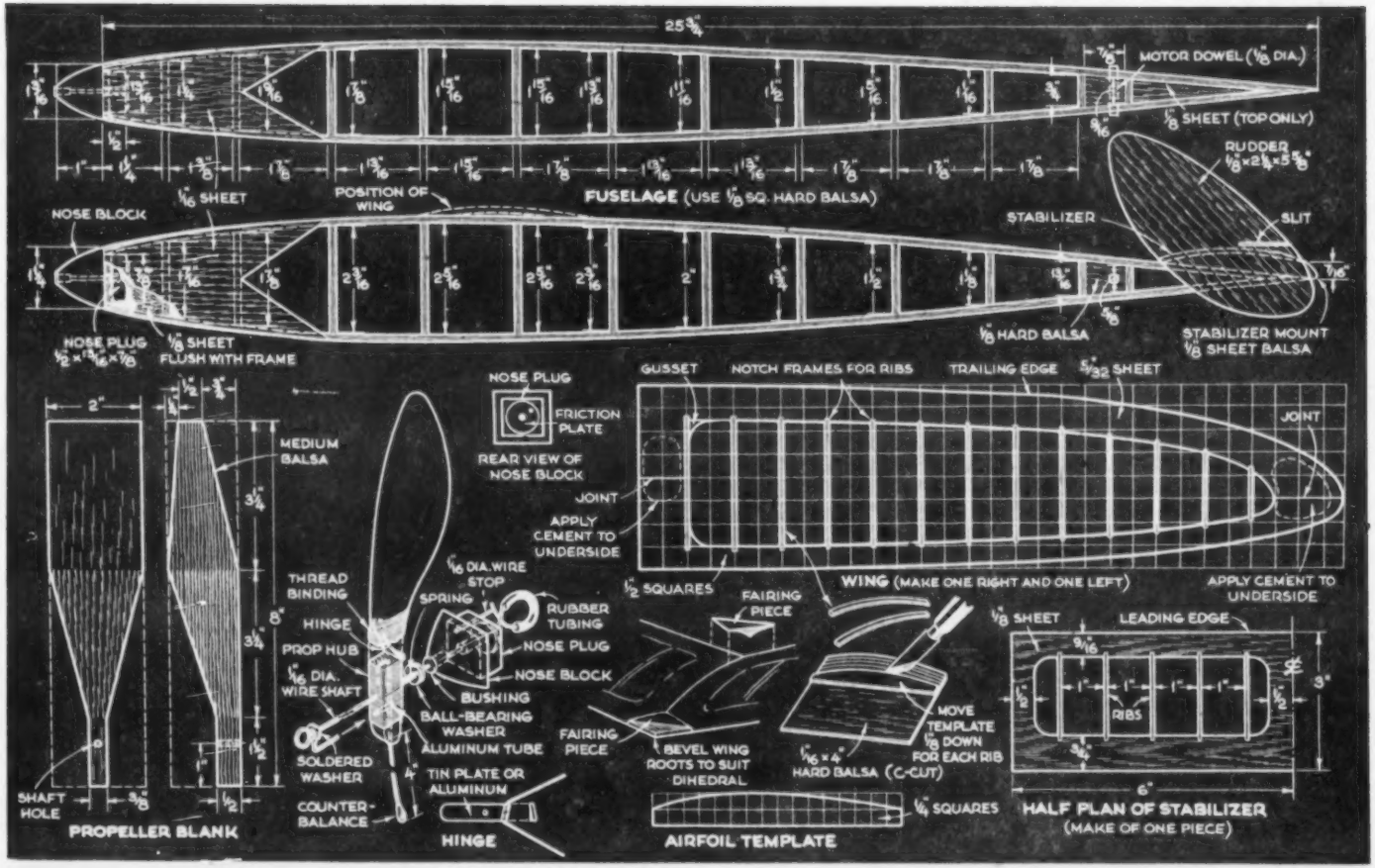
WHEN you fly this sleek little rubber model, you may be surprised at the altitude it reaches before the folding prop kicks in and the ship starts on a slow, flat glide. Its motor run is longer than you usually find in models of this size and an airfoil section with a deep camber produces a high lift.

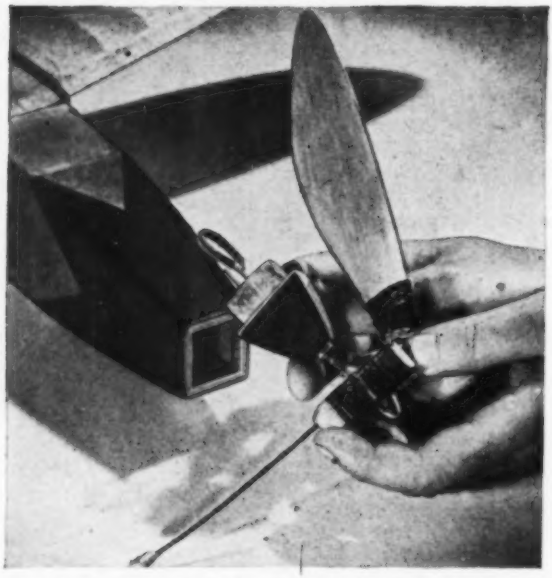
The wing frame is cut from 5/32″ medium sheet balsa, two sheets being cemented edge to edge. Inner edges are notched at intervals of 1″ to accept the ribs, all of which are cut to an airfoil shape by use of a template. Fit the ribs by inserting one end in a notch on the leading edge and cutting to suit the corresponding notch on the trailing edge. Sand the leading edge of the wing round and the trailing one sharp. (Sand the stabilizer and rudders in the same way when you come to them.)

When the ribs are firmly cemented in place and dry, bevel the wing roots for a joint that will provide a dihedral of 3¼″, and reinforce the joint with triangular fairing pieces. Cover the underside of the wing first, applying cement to the full length of each rib to get the indicated camber. Then cover the top in the conventional manner, water the tissue, allow to dry, and apply two coats of clear dope. The pull exerted by the covering when finally dry will increase the dihedral at the wing tips to about 4″.

Although the drawing shows the stabilizer frame only in half plan, it is cut as one piece from a 12″ length of ⅛″ sheet balsa. Build and cover it in the same manner as the wing, but note there is no dihedral. After shaping the rudders, make a slit in the trailing edge of each to allow for warping to give the model a gentle turn.

The fuselage is built in the regular manner, one side being shaped on top of the other. At the front, the first panel is filled all around with ⅛″ sheet set in flush with the longerons and crosspieces. Then this is covered with 1/16″ sheet extending back three panels, a deep V being cut in the back edge of each piece as shown. After


25 3/4"
MOTOR DOWEL (1/8" DIA.)
1/8" SHEET (TOP ONLY)
RUDDER 1/8"×2 1/4"×5 5/8"
1/16" SHEET
POSITION OF WING
FUSELAGE (USE 1/8" SQ. HARD BALSA)
NOSE BLOCK
STABILIZER
SLIT
NOSE PLUG 1/2"×13/16"×7/8"
1/8" SHEET FLUSH WITH FRAME
1/8" HARD BALSA
STABILIZER MOUNT 1/8" SHEET BALSA
MEDIUM BALSA
SHAFT HOLE
PROPELLER BLANK
NOSE PLUG
FRICTION PLATE
REAR VIEW OF NOSE BLOCK
THREAD BINDING
HINGE
PROP HUB
1/16" DIA. WIRE SHAFT
SOLDERED WASHER
COUNTER-BALANCE
1/16" DIA. WIRE STOP
SPRING
RUBBER TUBING
NOSE PLUG
NOSE BLOCK
BUSHING
BALL-BEARING WASHER
ALUMINUM TUBE
TIN PLATE OR ALUMINUM
HINGE
GUSSET
NOTCH FRAMES FOR RIBS
TRAILING EDGE
5/32" SHEET
JOINT
APPLY CEMENT TO UNDERSIDE
1/2" SQUARES
WING (MAKE ONE RIGHT AND ONE LEFT)
APPLY CEMENT TO UNDERSIDE
FAIRING PIECE
FAIRING PIECE
BEVEL WING ROOTS TO SUIT DIHEDRAL
1/16"×4" HARD BALSA (C-CUT)
MOVE TEMPLATE 1/8" DOWN FOR EACH RIB
1/4" SQUARES
AIRFOIL TEMPLATE
1/8" SHEET
LEADING EDGE
RIBS
HALF PLAN OF STABILIZER
(MAKE OF ONE PIECE)



After the power run, a spring on the shaft pulls the motor hook against a stop on the plug. This positions the prop for landing.

these pieces have been cemented in place, fair the edges with sandpaper before applying, watering, and doping the tissue.

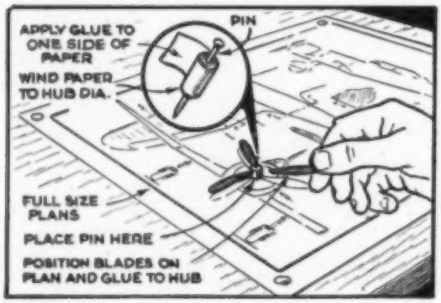
At the rear, ⅛" filler sheet also is installed in the side panels where the motor dowel is located and in the final V-shaped panel on top where the stabilizer goes. If desired, the panel under the dowel can be filled with a removable door. Install the dowel itself with a press fit for easier placing of the rubber. From ⅛" sheet balsa, shape a stabilizer mount conforming to the undercamber of the stabilizer and giving a slight negative incidence when the mount is centered and cemented on the filler sheet previously fitted between the longerons.

After carving the nose block, cut a friction plate from thin tinplate and cement it to the rear face of the block. Shape the propeller with an undercamber of about ⅛" and give it three coats of dope, sanding between each coat. The hinge must have the swivel at an angle and be carefully positioned so that the blade will fold back flush against the fuselage. Cement the hinge in place, forming the prongs to the lower part of the blade, and bind the entire hinge with thread. Then cut the propeller on the same plane as the hinge swivel. The counterbalance is a length of wire with a blob of solder at the end.

Since there is no landing gear, it is desirable to have the prop in a horizontal position when the model lands. This is accomplished with a spring that thrusts the shaft forward at the end of the motor run, throwing the motor hook against a wire stop on the nose plug. Although not absolutely essential, an aluminum tube into which the anchor prong of the shaft can be cemented in the hub will give greater strength.

Bend a loop on the front of the shaft for attaching the winder. The entire propeller assembly pulls out for winding.

Install between 16 and 20 strands of ⅛" flat brown rubber, lubricating it first, and the model is ready for the first test glides and adjustments. The original model used a ⅛" right down prop thrust, making it climb to the right, and when power ceased it glided to the left, but your adjustments may be different. When you are satisfied with the first short flights, give the rubber about 300 turns with a winder—and watch her go.



How to Position Prop Blades

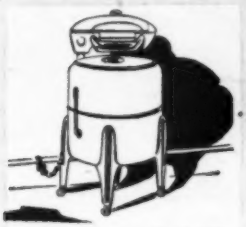
When you are building a small scale model of a plane, the blades of three- or four-blade props can be positioned at the correct angle by the procedure illustrated.

Cut a narrow strip of paper, apply glue to it, and wind around a straight pin until it equals the hub diameter. Then place the pin in the center of the hub on your plans and glue the blades to the hub in the indicated position.—Freddy Mitchell.

Home, Sweet Home — but is it safe?

Swinging cabinet doors cause many bumps. Install doors of the sliding type.

Ground the washing machine with a wire run to a water pipe for safety.



Folding gates of some sort are practically a must in homes where a child is learning to walk but hasn't yet mastered the stairs.

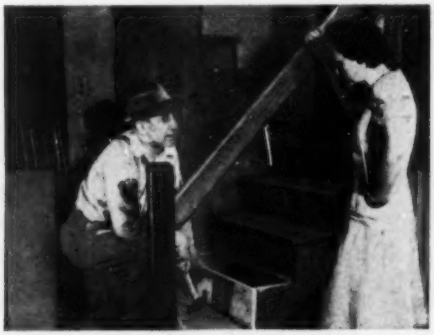
Handrails will help prevent bad falls on outside steps, particularly in icy weather.

When bumping hazards can't be removed, mark them with a bright paint.

WITH a little time and a few hand tools, you can make almost any home a lot safer. Some of the ways this may be done are suggested in the photographs and drawings on this and the following page, supplied through the courtesy of the National Safety Council, with headquarters in Chicago.

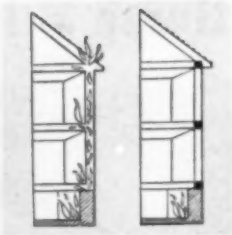
Most of these safety-engineering jobs are simple and within the capability of almost any man or woman of the house. Even if the services of a carpenter are required, the expenditure is money well spent. Check over your home and you undoubtedly will find other ways that you can help make it safe.

Many accidents occur on cellar stairs because of poor visibility. Paint white so you can see them.



If your cellar stairs are rickety, and many are, an easy job of carpentering will make them safer.

Grab bars, placed both vertically and horizontally, guard against a bone-breaking fall in the bathtub.



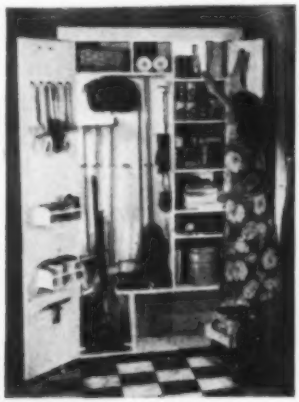
If you build or remodel, plan fire stops between floors, as indicated at the right above.

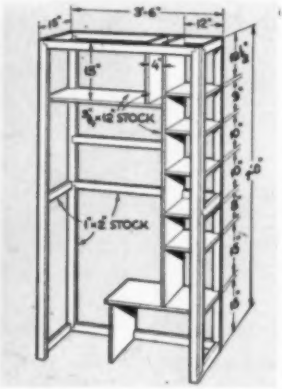
Wear makes electrical wires unsafe after a time. Check them over and either replace them or apply tape.

Shipshape Closet Has Space for All Housekeeping Equipment

MANY homes still get along with an old-fashioned broom closet that holds a broom or two and has one shelf for all the cleaning supplies. A bulletin issued by the National Safety Council reports that such closets have been indirectly responsible for many accidents in the home because "father stumbled over the electric cleaner hidden behind the bedroom door; baby sister was poisoned when she drank the disinfectant stored below the kitchen sink; and mother broke her ankle when she fell over the dust mop reclining on the basement stairs."

To bring order out of this chaos, the Council has designed the housekeeping closet shown in the accompanying illustrations and suggests that it be built against a vacant wall in the kitchen or hall. The closet was planned to allow space for all the things needed to keep a home spick-and-span. Mops, brooms, dustpan, and brushes have their own special hooks. Orderly shelves are spaced for containers of various sizes. A locked compartment above the shelves keeps poisons out of the reach of children. Metal cans hold oily dust cloths. The closet is shown with two doors, but if it is located in the corner of a room a single door, opening against the wall, may be preferable. To reduce the cost, the doors may be made of plywood.





Souvenir 40-mm. Shells Form Legs of Table

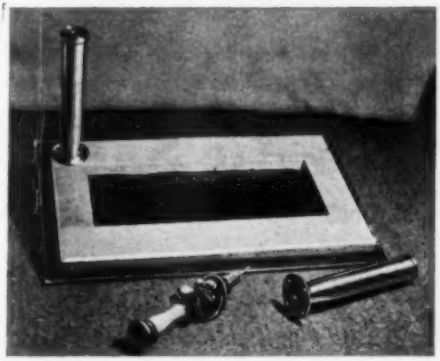
Gleaming brass and a lustrous plastic top mark this coffee table. The legs are shell casings to which are soldered disks to take mounting screws.

CRAFTSMEN who have or can obtain four 40-mm. shell casings have ready-made brass legs that will add style to a plastic-top coffee table. Drill four 3½″ brass disks to receive screws for attaching to the table and solder the disks to the open ends of the shells. Then clean the brass thoroughly, rubbing with fine emery cloth, and give it a spun-metal finish by rubbing with steel wool around the circumference.

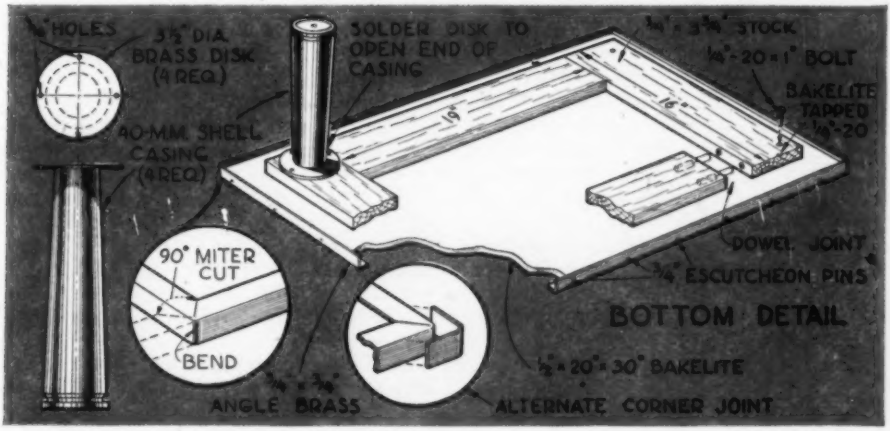
Bakelite or any opaque colored plastic will make a handsome top. Cut a ½″ sheet to a 20″ by 30″ rectangle and glue and bolt to it a doweled wood frame of ¾″ stock. Drill bolt holes through the wood and part way into the plastic, and tap the holes in the plastic. The legs are then screwed to the wood through the disks.

For edge trim on the plastic top use strips of ¾″ brass angle. Miter the corners carefully with a hacksaw and file until the fit is perfect. Two methods of finishing the corners are shown below—one by sawing a notch, bending, and soldering, and the other by mitering four lengths and soldering corner pieces on.

Clean and polish the brass edging to match the legs. If the surface of the plastic is scratched, remove the marks with fine pumice and a wet cloth. Lacquer the brass parts for a permanent finish, and wax the plastic periodically.—FRANK S. MYER.



Construction details, including the application of the brass-angle trim, are shown in the drawing below.



Sheathing is closed at the ridge and ripped to size to provide solid nailing for rip-rap or other trim.

How to Sheathe a Roof

SPACING FOR UNIFORM NAILING LENGTHENS LIFE OF SHINGLES

By Edwin M. Love

PART V OF A SERIES

FOUNDATIONS are not only put under a house. How you lay a foundation for shingles may add years to the life of a roof. In this case the foundation is sheathing.

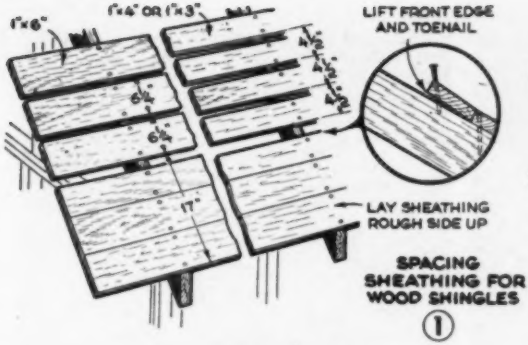
Starting boards should be of clear lumber, or at least free from loose knots, and some painting labor can be avoided if they are given one or two coats on the face while on sawhorses. For the first course select pieces of equal width and dress one side of each. Start support nails in a few rafters to keep the boards from sliding off, and tack the first boards to allow for shifting when they are straightened. Make joints on rafters and let them project as they will at the gables.

Length can be found by butting the far end of a board against its rafter and marking for the cut by the corresponding side of the near rafter. Then move the board back half the thickness to make the joint. Sight along the eaves, straighten the starting boards, and nail them fast. Lay enough tightly together to cover the overhang.

Roofs to be covered with paper or composition shingles are sheathed solid. The process is a continuation of that over the eaves. Time is saved by tacking the boards in place until a side is covered. Then start nailing at one rafter and continue along its length, attempting to emulate the carpenter who drives his nail in three blows and seldom misses a count until his handful is used up. Sheathing is laid rough side up.

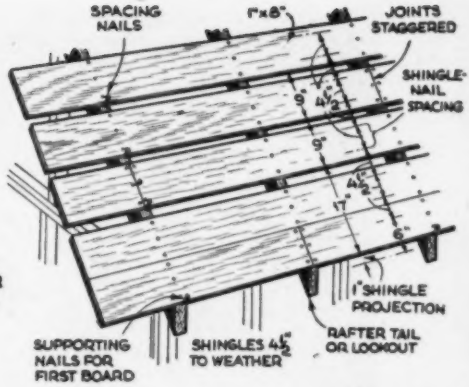
Most composition roofs are sheathed with 1″ by 6″ lumber, but other widths are acceptable. Stagger the joints and extend enough at the gables to carry the barge boards without noticeable sag. The spaces left are later filled in with scraps. Cover knotholes or loose knots with tin patches held with shingle nails.

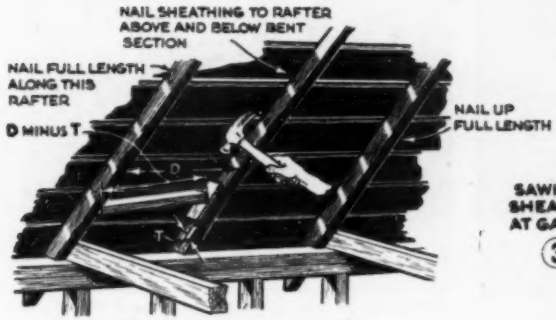
Sheathing for wood shingles is customarily spaced, not only to save material, but also to ventilate and dry the shingles, a



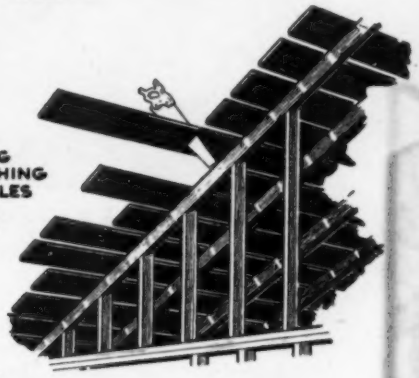
SPACING SHEATHING FOR WOOD SHINGLES

1





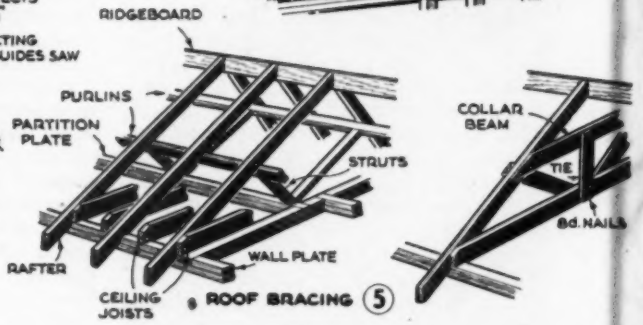
2 STRAIGHTENING BENT RAFTER



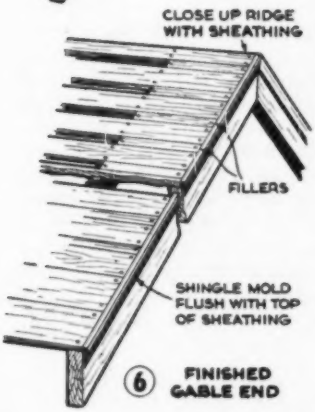
SAWING SHEATHING AT GABLES

3

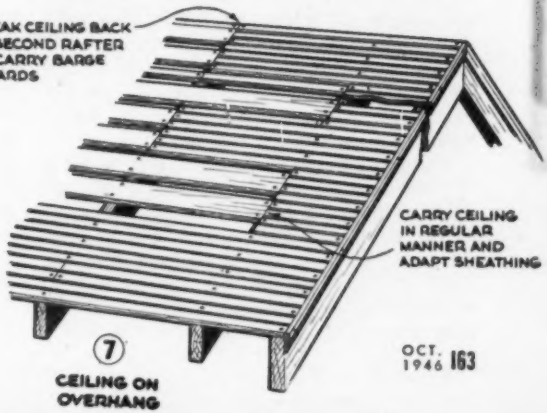
4 FITTING BARGE BOARD



ROOF BRACING 5

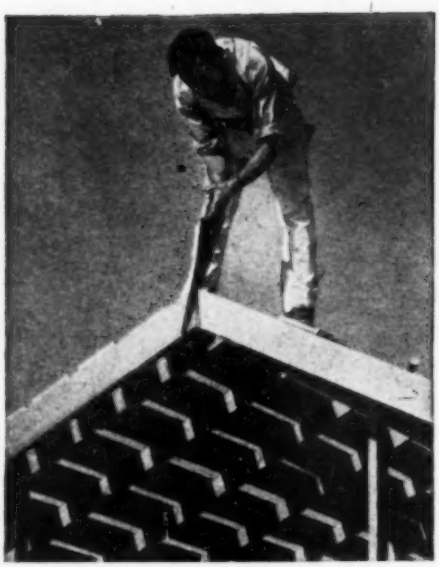


6 FINISHED GABLE END



7 CEILING ON OVERHANG

Space and tack sheathing in place for an entire side, and then nail it permanently. Nail along the length of one rafter at a time. The sheathing is laid with the rough side up.



If the joint between two barge boards does not fit perfectly, it can be corrected by running a fine saw between the ends, after which tacking is withdrawn and the second barge board moved up.

matter of considerable importance in damp climates. Many builders use 1″ by 4″ sheathing spaced about 2½″ apart. Much better is spacing that corresponds to the amount of shingle laid to the weather, as shown in Fig. 1. Thus, if the sheathing is laid 4½″ on centers and the first spaced board is placed 17″ above the eaves (or 17″ plus 4½″ or a multiple), shingle nails can be placed uniformly 6″ above the butts, with a coverage of 1½″ by the next course of shingles.

You will find 3″ sheathing just as satisfactory, and it will give more toe room as well as better space for inserting handfuls of shingles after the bundles are opened. If only 6″ sheathing is available, lay it 6¾″ on centers, and the spacing for shingle nails will not be too far from ideal. For 8″ sheathing, laid 9″ on centers, drive two rows of shingle nails in each course. Close the sheathing at the ridge to provide sound nailing for rip-rap or other trim.

While the sheathing is being nailed, straighten local side bends in the rafters. Nail neighboring rafters solid, and nail up the straight part of the crooked rafter; then go under the roof and drive in a spreader block to force out the bend, as illustrated in Fig. 2. Finally nail the sheathing to the corrected rafter and knock out the block.

When the sheathing is nailed, measure for gable projection at the ridge and eaves. Then strike chalk lines or draw pencil lines along a straightedge and saw off projecting boards, as in Fig. 3.

Barge boards, the rafterlike members that frame the gables (Fig. 4), are of 2″ clear stock, usually 6″ or 8″ wide. Select pieces to cut in pairs (the upper ends only) with crowned edges up and the best faces out. Hanging them is a two-man job. Locate the upper end of the first by butting it against a strip nailed at the center of the ridge, and then tack it, springing it in or out to conform to the sheathing before final nailing.

To place the second barge board, start a few nails in the sheathing and tack it, holding the board in place with the upper end against the first board a little above and behind it. Inspect the joint and, if it does not fit, run a fine saw through it, as shown in Fig. 4. Withdraw the nails, drive new ones, and tack again. If the fit is satisfactory, tack again and toenail through the upper edge into the first barge board to drive it down; then nail solidly and finish nailing the board. Plumb a line at one end of each barge board and cut it to length.

The roof is now ready for bracing (Fig. 5). If narrow, it may require only a sway

When both the barge boards have been permanently nailed in place, plumb a line at the ends and saw them off vertically to length. They are held to the roof simply by nails through the sheathing.

Short lengths of filler strips may be nailed in between the sheathing from the barge boards to the first rafters if a rustic effect with shingles showing through is not desired.

brace, or it may be possible to support it by means of posts from partitions carrying purlins nailed across the rafters midway between ridge and plates. In any event, check with the local building office.

Where partitions are lacking, use 1″ by 6″ collar beams nailed across alternate rafters halfway up, and bring struts down from the centers of the beams to the centers of the ceiling joists. In most cases the sheathing will have drawn the rafters into alignment, but some sag may be present near the center of the roof, and this should be checked before braces are nailed permanently. If necessary, prop up the sags from the floor until collar beams are placed.

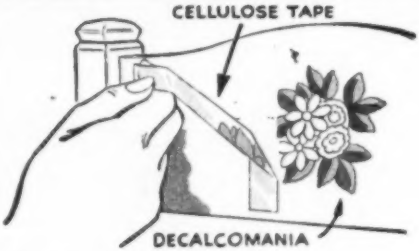
Before shingling, nail in fillers and nail shingle molding to the barge boards with the upper edge flush with the top of the sheathing, as in Fig. 6. This hides the ends of sheathing boards and is a neat finish.

Figure 1 shows ceiling board on the overhang. The ceiling breaks back to the second rafter only at intervals so the pull of the barge board will not spring that rafter and cause a hump that might split the shingles. For more rustic effects, finish-nail sheathing on from beginning to end as on the main roof. This allows the shingles to show between the sheathing at the overhang.

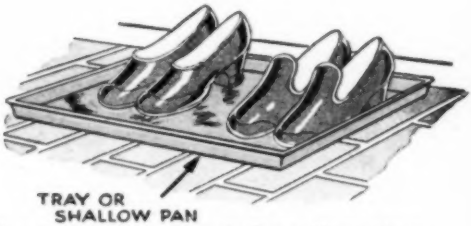
Collar beams nailed halfway up between alternate rafters supply bracing at points where partitions do not come. Use 1″ by 6″ boards.

KEEPING the HOME SHIPSHAPE

Shelves built under the cellar stairway provide storage space for canned foods. Cleats nailed to the inner faces of the stringers at the level of the treads will support the shelves. Another idea is to remove the drawers from an old bureau and replace them with shelves, as illustrated above.

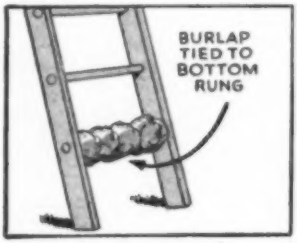


Scotch tape can be used to peel water-set decals from furniture without marring the surface. Stick a strip of the tape on the decal, smooth it, and then lift. The decal will come up with the tape.

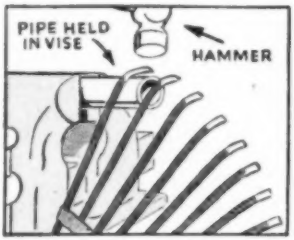


Your floors will remain much cleaner if you place a cookie sheet or tray on the floor near the door and ask all the family to put their wet or muddy rubbers there the moment that they come in.

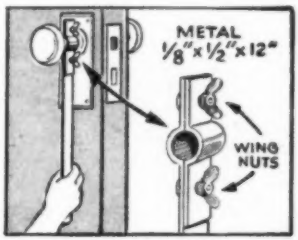
Burlap wrapped and tied around the first rung of a ladder will help keep the upper rungs clean of mud in wet weather and thus make your footing more secure.

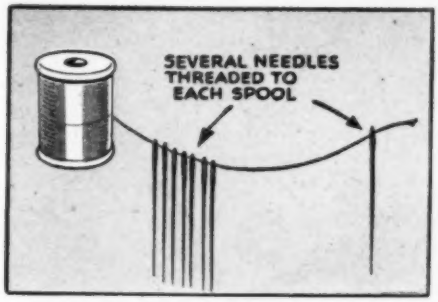


When leaf rakes with metal tines lose their bite, new hooks can be shaped as below. Clamp a piece of pipe in a vise and hammer a new hook in the end of each tine.

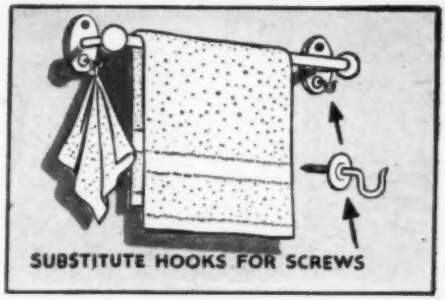


When a small child can't quite reach a doorknob, this gadget will save adults of the house many steps. Metal is best, but it might also be made of wood.

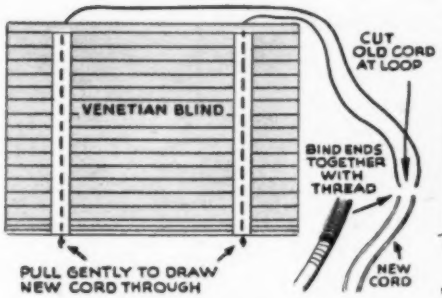




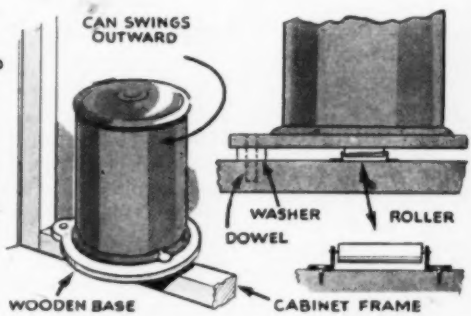
Needles threaded as above will be helpful for a person having poor eyesight. One needle then can be used with each piece of thread cut off.



To increase the capacity of a towel rack, remove the lower screws and substitute hooks. Additional towels or face cloths can be placed on the hooks.

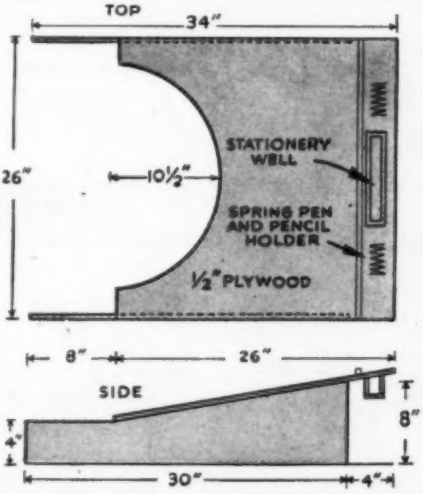


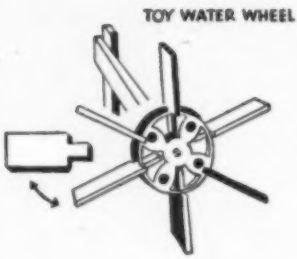
By the method shown above you can install new cords in Venetian blinds without taking them down. Cut the old cord, splice on the new one, and slowly pull the old one out and new one in.

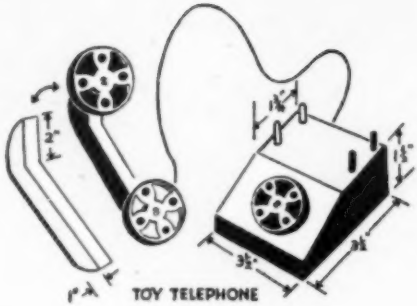


A step-on garbage can installed under the sink as above may be quickly swung out with the foot when needed. The outer can is screwed permanently to a pivoted wooden base that rides on a small roller.

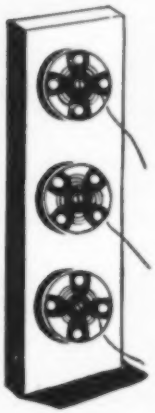
A semicircular section cut from this writing desk enables a person in bed to adjust it in a comfortable position against his body. At the top are springs to hold pens and pencils, and a cleat to keep them from rolling down. The well for stationery measures 1" by 3" by 6".







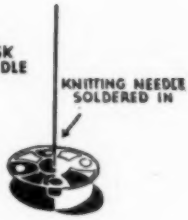
SPOOLS FOR WIRE OR STRING



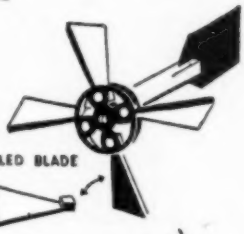
Ten Uses for Typewriter-Ribbon Spools

EMPTY typewriter-ribbon spools are discarded by the hundreds in many offices and schools, and in homes where a typewriter is used one becomes available occasionally. Here are some quick ways of transforming them into useful parts again. When a spool is used as a revolving member, it is a good idea to equip the bolt, screw, or other axle with washers on each side of the spool to cut friction.—RALPH S. WILKES.

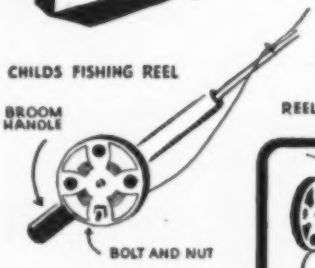
DESK SPINDLE



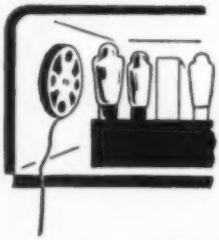
TOY WINDMILL



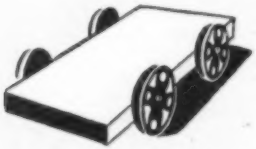
CHILDS FISHING REEL

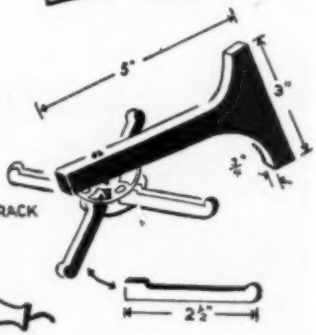


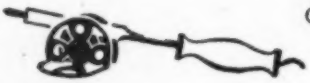
REEL FOR PORTABLE AERIAL



WHEELS FOR TOYS

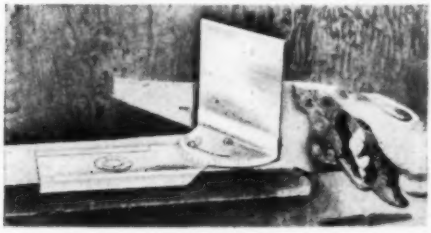






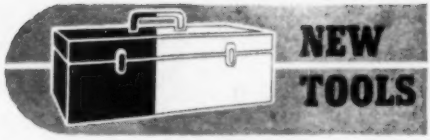
SOLDERING-IRON STAND

A BELL-SHAPED GUARD on a rotary drill press planer distributed by A. D. McBurney, of Los Angeles, is designed to protect the hands and keep chips from flying upward. A single cutting blade and one-spot adjustment are other features. Known as Safe-T-Plane, the planer fits any drill press, and will plane, rout, panel, bead, or rabbet to various depths in wood. Cutters for metals are available.

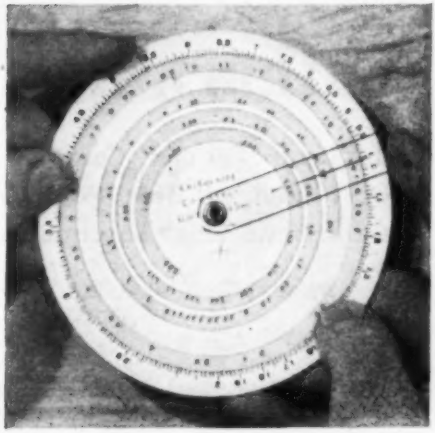


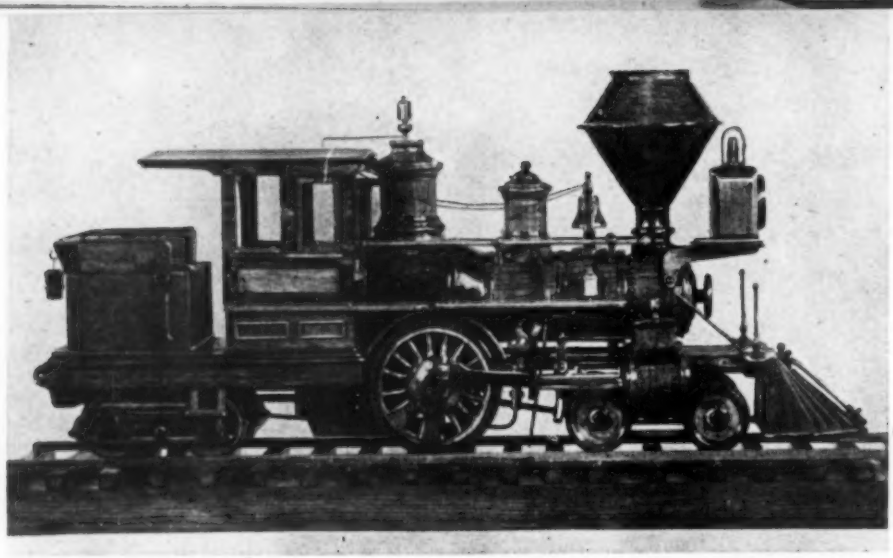
SAWING TO AN ANGLE is easier with an all-metal saw guide that fits boards of any size and will accommodate any handsaw. A turn of a wing nut quickly secures the miter head at the desired angle. The Bonaire Company, of Minneapolis, Minn., makes it.

NEEDLE BEARINGS, providing smooth, low-friction running without play, are a feature of a new grinding and polishing head produced by the Darra-James Corp., of Waterbury, Conn., for industrial and home-workshop use. The head itself is a solid bronze casting, the shaft is of hardened steel, and the pulley is machined from solid aluminum.



POCKET-SIZE CONVENIENCE is combined with hairline accuracy in the simplified Calculaide Commerce slide rule developed by American Hydromath Company, of New York. Made of plastic 4½" in diameter, the circular slide rule has the most-used scales close to the edge so that each is actually 12½" long. Conventional C and D scales, plus a spiral log-log scale ranging from 1.01 to 100, are provided.





Glued to a short length of track on a wooden base, the model of the C. P. Huntington is ready for display.

Southern Pacific Engine No. 1

Boiler and Fittings Complete Your Model of This Famous Old Diamond-Stack Locomotive

By ALFRED D. SLATER

Part II

IF YOU have completed the drive mechanism, frame, wheels, trucks, and other parts of your model of the C. P. Huntington as described in a previous article (see PSM, Sept. '46, p. 170), you are ready to proceed with the boiler, cab, and miscellaneous fittings that will bring your work to finished shape.

On the prototype, the link motion, which is illustrated in Fig. 12 on page 173, was used to control direction and speed, the engine being in full forward gear, or full backward gear, according to whether the slotted link was pulled entirely over one way or the other. When the link was in middle position neither eccentric operated and the engine came to halt. At intermediate positions, the valve stem was influenced by both eccentrics; and the point of cutoff, and therefore the speed of the engine, could be varied at will.

Since this wooden model of the famous locomotive is purely decorative, the eccentrics are left loose on the driver axle. Make the component parts as shown in Fig. 12, noting that only three levers are required because a control rod to the cab is placed on just one side of the engine. Assemble the various pieces with glue.

The boiler (Fig. 13) consists of two cylinders, 1¾″ and 1 15/16″ in diameter, an irregular conic expansion section, and a firebox, arranged in that order from front to back. The top portion of the firebox is semielliptical in cross section, having a major-axis half length of 1 9/32″ and a minor-axis half length of 1 3/32″. Under the bottom of the firebox cement an ashpan 5/16″ by 1 5/8″ by 2 3/32″ in size, with edges beveled. Against the rear of the firebox and boiler, cement a boiler head of the size shown, rounding the top edge.

Supporting the boiler at the front end is a ⅜″ by 1 11/16″ wooden pin thrust into the cylinder and the front-truck saddle. At the rear a ¼″ by ¼″ by 2 3/16″ cross member screwed to one of the main-frame cross-pieces provides support. Rivets are simulated with escutcheon pins on ¼″ centers. Boiler strapping may be made of thin cardboard, strips being cut 3/16″ wide.

A bracket, detailed in Fig. 17, supports the running board. At a point about 1¼″ ahead of the cab the running-board width should be decreased by ⅜″ on the outer edge, a diagonal cut being made toward the

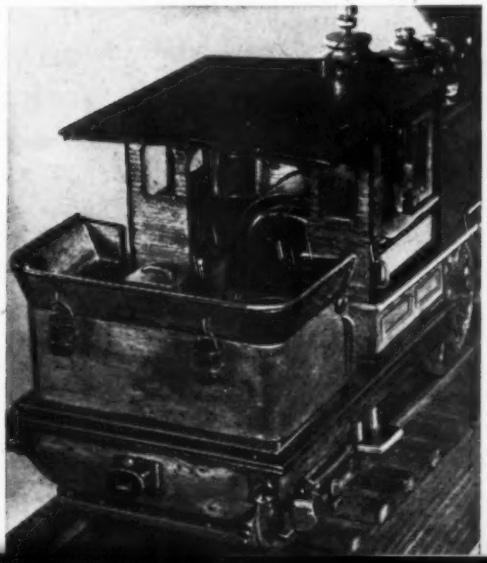
front of the engine above the driver hub.

The 3/32" tube leading from the bottom of the pump (Fig. 13) should be carried back far enough so that the end is hidden by the rear truck. Glue the mudguard to the underside of the running board, positioning it directly over the driver. Support each of the two 1/16" grabrails by two 1/16" ball-head stanchions glued into holes drilled in the boiler, and glue the rear end of the rails to the forward face of the cab.

Under the cab and the tank (Fig. 14) runs a 1/8" by 15/32" baseboard, the top of which is even with the top of the rear buffer. Atop this baseboard is set a 5/32" floor plate that has a 3/32" half-round molding around its edge except in the place where the firebox goes. The cab and tank flooring pieces are 3/32" thick and are beveled as shown in Figs. 14 and 15. Along either side of the cab runs a 13/16" by 1 3/16" by 2 25/32" seat which exactly fills the space between the cab flooring and the running board. The outboard side of each seat is decorated with two rectangles of glued-on cardboard moldings.

The West still was new when the C. P. Huntington, above, began chugging over the California rails. It now is permanently displayed in Sacramento.

On the model, it is best to use wire for some of the fittings. The tank is carved from solid wood.



Make the cab walls and roof from 1/16" plywood. After cutting window openings in the walls as indicated, frame them where shown with 1/16" cut-out backing pieces. Isinglass glued inside will give realism to the windows, and, if desired, an arm rest may be glued at the base of the open rear window. Cut the tank body from a single piece of wood, and glue on the flanges, brackets, and manhole. The grillwork around the flange top, the grab rods, and the manhole-cover handle may best be made of wire. Two pails and two steps complete the cab and tank.

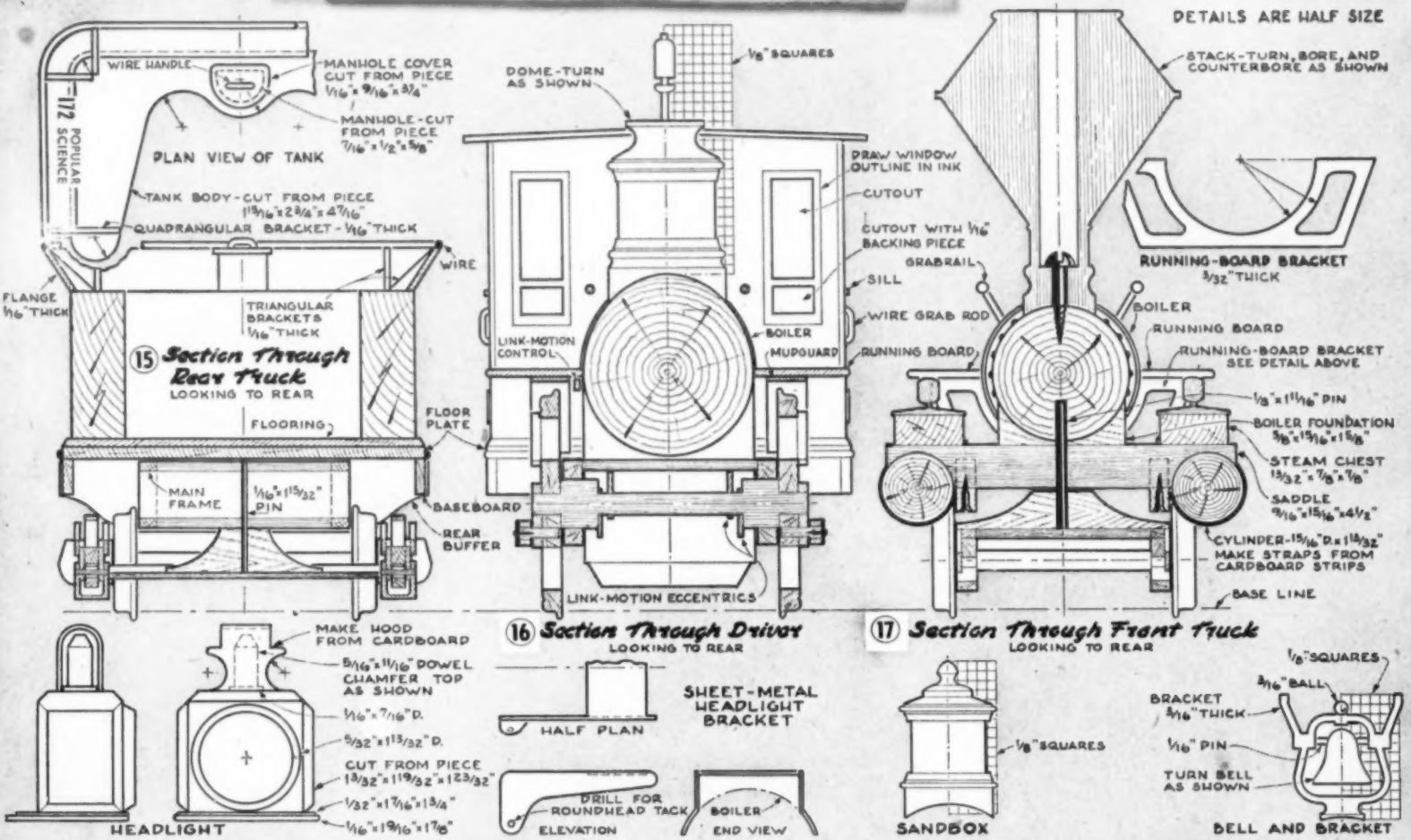
It is unnecessary to make the bell bracket a jointed affair that actually permits the bell to ring. A solid frame fashioned from a single 3/16" piece of wood will suffice. The bell itself can be turned on a lathe, or it may be that you can find a toy one that will serve the purpose.

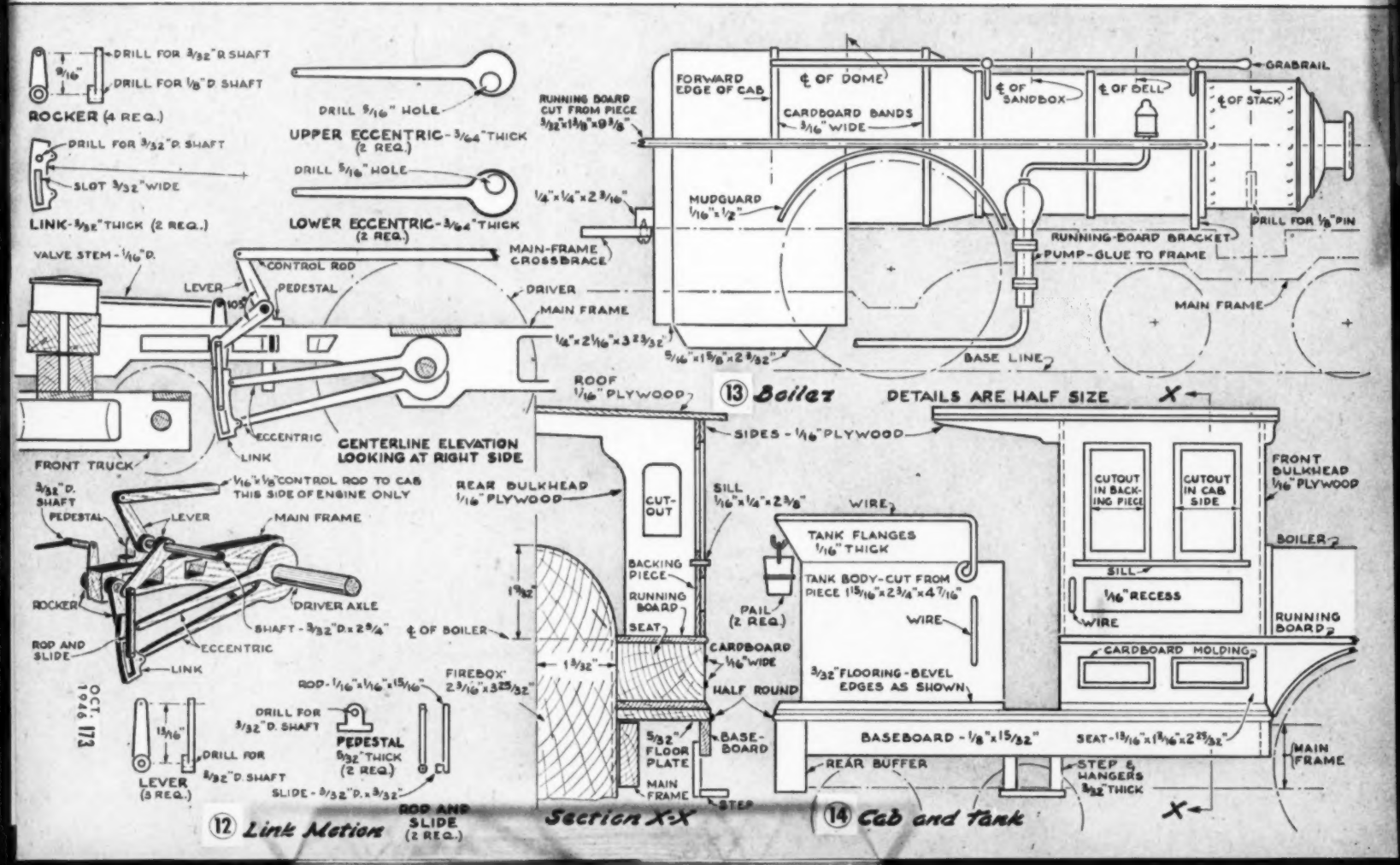
After the dome (Fig. 16), sandbox, and stack are turned, they may be fitted to the boiler contours either by carving and filing or by shaping on sanding drums of diameters equal to those of the boiler at the various places where the fittings are located. The headlight bracket of this particular model was laboriously carved from wood, but it may just as well be cut from a piece of tin-can stock, bent to shape, and fastened with two roundhead tacks.

There are several possible ways to finish the model. The color scheme of the original Huntington consisted of an elaborate combination of cherry, green, various reds, nickel, black, and gold. The pictured model is finished in black-walnut and colonial-maple stains and several coats of thin shellac. A realistic and attractive appearance also may be obtained by applying two coats of metallic flat black to the smokebox, stack, and firebox; then two coats of gloss black elsewhere, rubbing down with No. 000 sandpaper between coats.

Mount the model on a short length of wooden track glued to a beveled wooden base, and it's ready for your mantelpiece.

Detailed plans for completing this model of the engine are given on the next two pages.


DETAILS ARE HALF SIZE
WIRE HANDLE
MANHOLE COVER CUT FROM PIECE 1/16" x 9/16" x 3 3/4"
MANHOLE-CUT FROM PIECE 7/16" x 1/2" x 5/8"
112 POPULAR SCIENCE
PLAN VIEW OF TANK
TANK BODY-CUT FROM PIECE 1 15/16" x 2 3/4" x 4 7/16"
QUADRANGULAR BRACKET-1/16" THICK
WIRE
FLANGE 1/16" THICK
TRIANGULAR BRACKETS 1/16" THICK
15 Section Through Rear Truck
LOOKING TO REAR
FLOORING
FLOOR PLATE
MAIN FRAME
1/16" x 1 5/32" PIN
BASEBOARD
REAR BUFFER
DOME-TURN AS SHOWN
1/8" SQUARES
DRAW WINDOW OUTLINE IN INK
CUTOUT
CUTOUT WITH 1/16" BACKING PIECE
GRABRAIL
SILL
WIRE GRAB ROD
LINK-MOTION CONTROL
BOILER
MUDGUARD
RUNNING BOARD
LINK-MOTION ECCENTRICS
16 Section Through Driver
LOOKING TO REAR
STACK-TURN, BORE, AND COUNTERBORE AS SHOWN
RUNNING-BOARD BRACKET
3/32" THICK
BOILER
RUNNING BOARD
RUNNING-BOARD BRACKET SEE DETAIL ABOVE
1/8" x 1 11/16" PIN
BOILER FOUNDATION 3/8" x 1 9/16" x 1 5/8"
STEAM CHEST 1 3/32" x 7/8" x 7/8"
SADDLE 9/16" x 1 5/16" x 4 1/2"
CYLINDER-1 5/16" D x 1 15/32"
MAKE STRAPS FROM CARDBOARD STRIPS
BASE LINE
17 Section Through Front Truck
LOOKING TO REAR
MAKE HOOD FROM CARDBOARD
5/16" x 11/16" POWEL CHAMFER TOP AS SHOWN
1/16" x 7/16" D.
5/32" x 1 13/32" D.
CUT FROM PIECE 1 3/32" x 1 19/32" x 1 23/32"
1/32" x 1 7/16" x 1 3/4"
1/16" x 1 9/16" x 1 7/8"
HEADLIGHT
HALF PLAN
SHEET-METAL HEADLIGHT BRACKET
DRILL FOR ROUNDHEAD TACK
ELEVATION
BOILER
END VIEW
1/8" SQUARES
SANDBOX
1/8" SQUARES
3/16" BALL
BRACKET 3/16" THICK
1/16" PIN
TURN BELL AS SHOWN
BELL AND BRACKET


DRILL FOR 3/32" R SHAFT
DRILL FOR 1/8" D SHAFT
9/16"
ROCKER (4 REQ.)
DRILL FOR 3/32" D. SHAFT
SLOT 3/32" WIDE
LINK-3/32" THICK (2 REQ.)
DRILL 5/16" HOLE
UPPER ECCENTRIC-3/64" THICK (2 REQ.)
DRILL 5/16" HOLE
LOWER ECCENTRIC-3/64" THICK (2 REQ.)
VALVE STEM-1/16" D.
CONTROL ROD
LEVER
PEDESTAL
105°
MAIN-FRAME CROSSBRACE
DRIVER
MAIN FRAME
1/4" x 2 1/16" x 3 23/32"
ECCENTRIC
LINK
FRONT TRUCK
CENTERLINE ELEVATION LOOKING AT RIGHT SIDE
3/32" D. SHAFT
PEDESTAL
LEVER
1/16" x 1/8" CONTROL ROD TO CAB THIS SIDE OF ENGINE ONLY
MAIN FRAME
ROCKER
DRIVER AXLE
SHAFT - 3/32" D. x 2 3/4"
ROD AND SLIDE
ECCENTRIC
LINK
13 3/32"
℄ OF BOILER
13 3/32"
FIREBOX 2 3/16" x 3 25/32"
ROD - 1/16" x 1/16" x 15/16"
DRILL FOR 3/32" D. SHAFT
PEDESTAL 5/32" THICK (2 REQ.)
13/16"
DRILL FOR 3/32" D. SHAFT
LEVER (3 REQ.)
SLIDE - 3/32" D. x 3/32"
ROD AND SLIDE (2 REQ.)
12 Link Motion
OCT. 1946 173
RUNNING BOARD CUT FROM PIECE 3/32" x 1 3/16" x 9 3/8"
FORWARD EDGE OF CAB
℄ OF DOME
CARDBOARD BANDS 3/16" WIDE
℄ OF SANDBOX
℄ OF BELL
GRABRAIL
℄ OF STACK
1/4" x 1/4" x 2 3/16"
MUDGUARD 1/16" x 1/2"
DRILL FOR 1/8" PIN
RUNNING-BOARD BRACKET
PUMP-GLUE TO FRAME
MAIN FRAME
5/16" x 1 5/8" x 2 3/32"
BASE LINE
13 Boiler
DETAILS ARE HALF SIZE
X
ROOF 1/16" PLYWOOD
SIDES - 1/16" PLYWOOD
REAR BULKHEAD 1/16" PLYWOOD
CUT-OUT
SILL 1/16" x 1/4" x 2 3/8"
WIRE
TANK FLANGES 1/16" THICK
BACKING PIECE
RUNNING BOARD
SEAT
PAIL (2 REQ.)
TANK BODY-CUT FROM PIECE 1 15/16" x 2 3/4" x 4 7/16"
WIRE
CARDBOARD 1/16" WIDE
HALF ROUND
3/32" FLOORING-BEVEL EDGES AS SHOWN
5/32" FLOOR PLATE
BASE-BOARD
MAIN FRAME
STEP
Section X-X
CUTOUT IN BACKING PIECE
CUTOUT IN CAB SIDE
FRONT BULKHEAD 1/16" PLYWOOD
BOILER
SILL
1/16" RECESS
WIRE
RUNNING BOARD
CARDBOARD MOLDING
BASEBOARD - 1/8" x 15/32"
SEAT - 13/16" x 1 3/16" x 2 25/32"
MAIN FRAME
REAR BUFFER
STEP & HANGERS 3/32" THICK
X
14 Cab and Tank

When the diameter of a hole is being measured, the thimble is adjusted until the pointer indicates zero.

Indicating Inside Calipers

By FRANK McCARTY

NOT all of us are in the position of the old-time master machinist who could "feel" when caliper and micrometer measurements were exactly right. For the less experienced whose "feel" with inside and vernier calipers and inside micrometers is too often uncertain, the indicator calipers shown here will reduce the chances of error.

One leg is clamped at the approximate setting called for by the measurement being taken, and the other is then adjusted by a screw until a pointer indicates zero. The contact points are next measured with an outside micrometer to the same pointer reading. A correct measurement is thus obtained by sight instead of touch. The instrument has a range of ½" to 6".

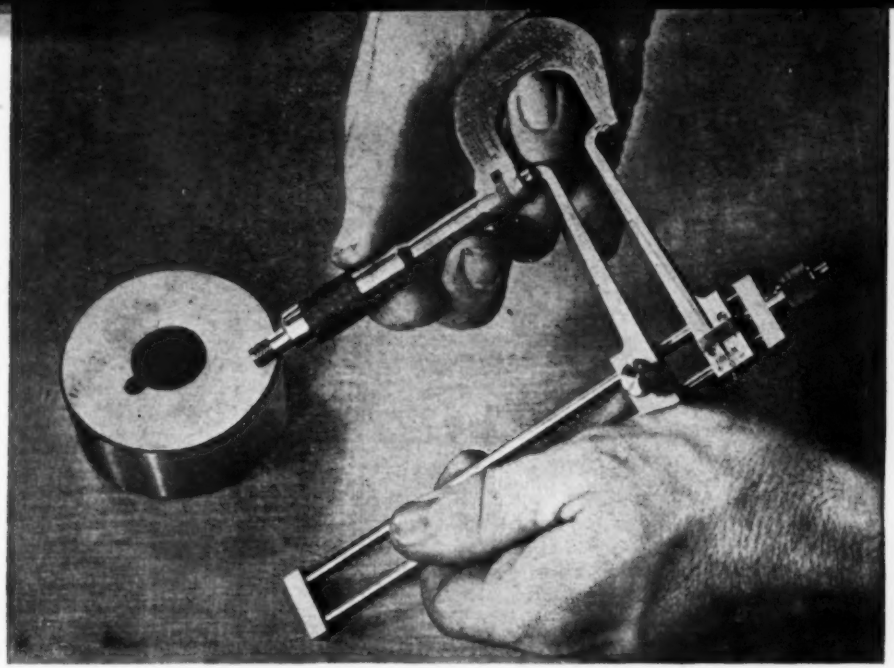
Shaft holes are accurately spaced in the frame blocks by the simple jig shown on the facing page. Holes larger than ¼" are redrilled outside the jig. All four blocks should be marked so they can be assembled on the shafts in the same position as drilled.

The ratio of the lever action of the pointer is 1 to 11. A .001" movement at the foot will register .011" on the scale and, as the calibration marks are spaced 1/32" apart, each space will represent an actual movement of .003". Plus and minus marks determine when the true diameter is being measured and also indicate taper and out of round.

Make the blocks of mild steel. Drill all three holes in the front frame block in the jig, redrill the middle hole to 3/16", drill No. 47 setscrew holes into each end of the shaft holes from the back, and tap them 3-48. The rear frame block is drilled the same way except that the middle hole is omitted.

All three holes are drilled in the indicator-leg block with the jig. The center hole is then redrilled with a No. 21 drill and threaded with a 10-32 tap. Both outside holes should be reamed to 3/16" for a snug fit on the shafts. If a reamer of this size is not available, redrill with a No. 14 drill (.182"), finish with a correctly sharpened 3/16" drill, and lap with a piece of fine emery cloth on the end of a ⅛" rod.

No middle hole is required in the adjustable-leg block, and the two outside holes are treated the same as those in the indicator block. The clamp-screw hole is drilled through with a No. 21 drill and threaded with a 10-32 tap. A 1/32" slot is then cut down from the top of the block through the center of one hole and into the other, after



The calipers are removed from the work and a micrometer adjusted on them until zero is again indicated.

which the threaded hole is redrilled with a 3/16″ body drill from the front face to the slot.

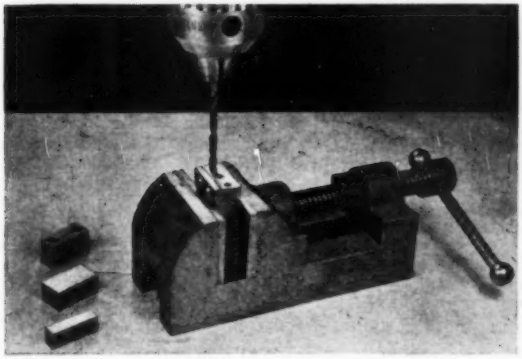
For the shafts, two pieces of 3/16″ drill rod are turned down to ⅛″ diameter for ¼″ on each end, and polished. To make the clamp screw, knurl one end of a bit of 7/16″ drill rod, turn the head and shank, and thread the latter. Then cut the screw off, reverse it in a smaller collet, and face the top of the head.

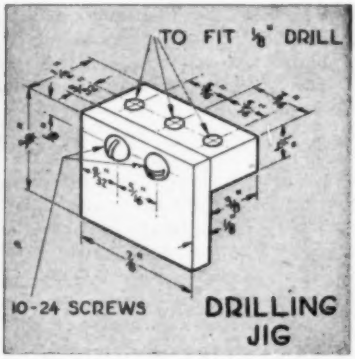
The threaded spindle is 5/16″ drill rod, turned for 1⅛″ to 3/16″ diameter and faced off at the end with a slight radius. Reverse it in a 3/16″ collet, turn the other end for ½″ to 3/16″ diameter, leaving a 1/32″ shoulder, and thread 10-32 to fit the indicator block.

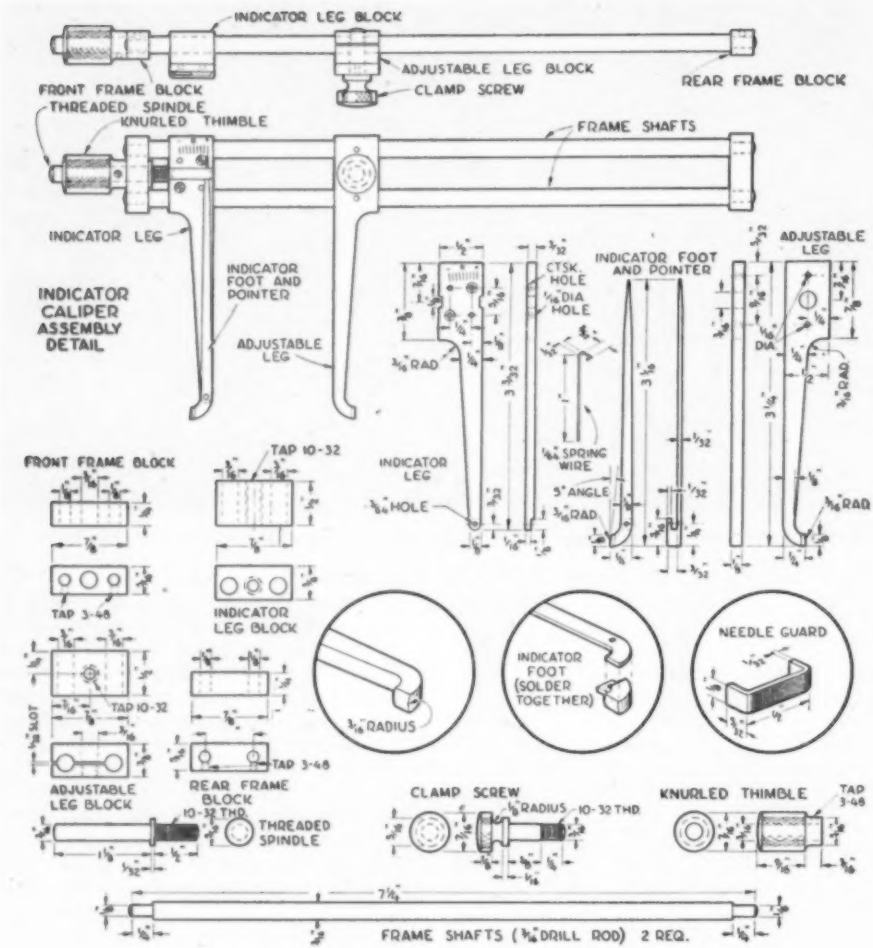
In one chucking the thimble, made of 7/16″ drill rod, can be knurled, turned, and drilled 3/16″. After cutting off, reverse the piece and face the other end with a slight radius. A No. 47 setscrew hole is drilled and tapped 3-48 in the smaller diameter for assembly on the spindle shank.

Hacksaw the adjustable leg from ⅛″ mild steel, finish-file to shape, and polish with emery cloth and oil. Clamp it on the frame block, drill holes a tight fit for 1/16″ pins, and press in the pins after cutting these 3/16″ long and filing them slightly on one end. The clamp-screw hole is picked up

Accurate alignment on the shafts will be assured if the frame blocks are drilled in a homemade jig like that shown below. Holes that are to be larger than ⅛″ diameter are redrilled to size outside the jig.







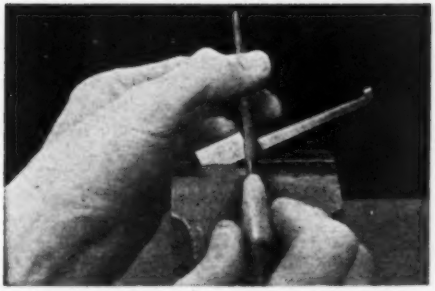
from the back with a No. 21 drill and redrilled from the front with a 3/16″ drill. File the outside of the foot to a 3/16″ radius to permit only one contact when measuring.

The indicator leg is sawed and filed to the same profile from 3/32″ stock, but without a foot. File the lower end to act as the butt of a hinge for the pointer. Locate the calibration marks on an arc scribed from the hinge-pin position. These marks should be laid out first with India ink 1/32″ apart, and then stamped into the surface with a small chisel made by grinding a sharp edge on a hardened pin or punch. Stamp a small zero over the middle line with a new nail-set punch.

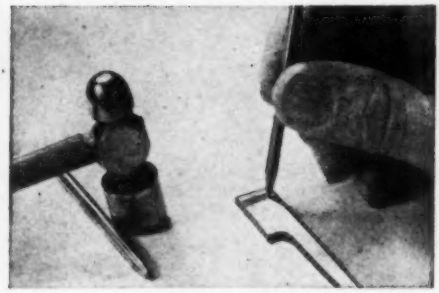
Drill four 1/16″ holes for fastening the leg to the frame block. Countersink two holes on a diagonal for small machine screws—the other two are for pins. The 0-80 size is ideal, but if a tap smaller than 2-56 is not available, this size will do.

Clamp the leg on its block, respot the holes, and drill the pin holes with a 1/16″ drill. Then drill the screw holes and thread 0-80 or 2-56. Shape a guard for the pointer from 1/32″ sheet metal and solder in notches filed in the side of the leg.

The indicator pointer is made in two pieces with a recess filed in the foot to fit over the bottom of the leg. Solder together tightly and finish-file to appear as one piece. The radius on the foot will have to be on an



Both the indicator leg and adjustable leg can be hacksawed to shape and finish-filed and polished.



Calibration marks for the indicator scale are put on with India ink and then stamped with a chisel.

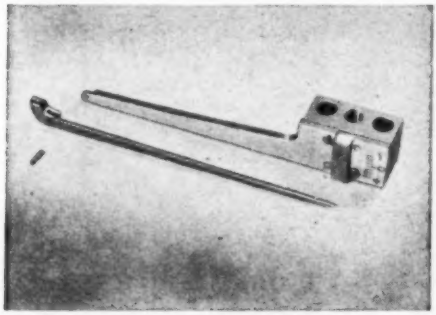
angle so there will still be only one contact.

Fit the pointer over the leg and drill both together at the hinge with a 3/64″ drill. A small piece of steel knitting needle can be used as the hinge pin. Shape 1/64″ spring wire as shown, and solder it to the back of the foot just above the pin to provide tension when it is hooked about the back of the leg.

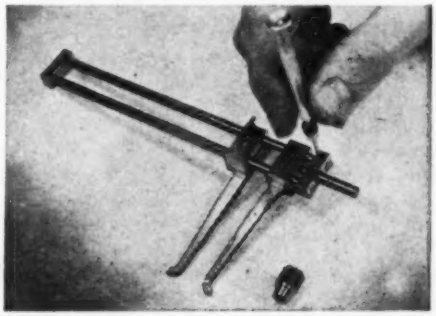
Assemble the legs and blocks on the shafts and tighten the setscrews. If 3-48 setscrews cannot be obtained, cut short lengths from the ends of roundhead machine screws after slotting the ends with a fine saw. No. 6 screws will do if the pitch is as fine as 40.

Screw the spindle into the indicator block and push the shank through the end block. Slip the thimble over the spindle shank against the end block; then tighten the setscrew. Apply a coat of any good rust preventive to preserve the finish.

Here is the indicator leg with its pointer and hinge pin. The contact foot is on the pointer.



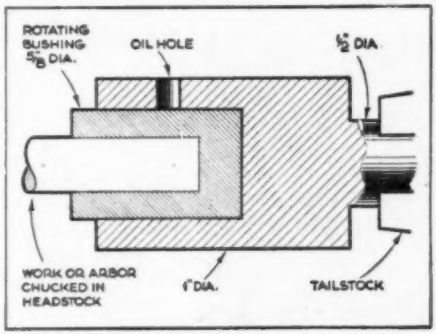
Setscrews hold the end blocks on the shafts. Note the tension spring on the right-hand pointer foot.



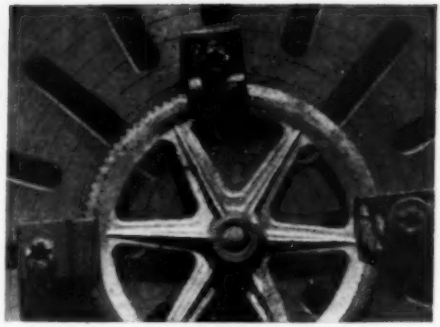
Tailstock Live Center Is Equipped with Revolving Bushings

When centerdrilling is undesirable, work can still be centered accurately on the lathe tailstock with a live center like the one shown at right. Turn the body from 1″ brass rod, drill a ⅝″ hole in the end 1″ deep, and drill a small oil hole in the top. The "live" part of the tailstock center is a bushing 1¼″ long cut from ⅝″ brass rod. It revolves in the body when well oiled and centers the work automatically.

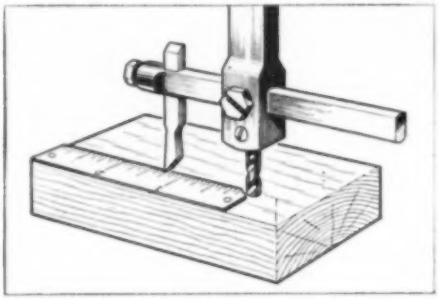
Cut a number of bushing blanks and drill them to receive work of various sizes as needed. If you save them, you will soon have a complete set.—H. P.



NEW SHOP IDEAS

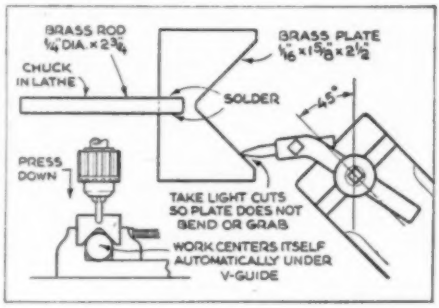


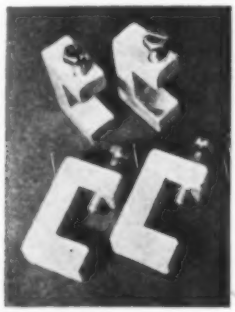
AUTOMOBILE RIM CLAMPS provide an efficient way to fasten work to the faceplate of a lathe, since the right-angle ends often eliminate the need for blocking. Clamps are available at little cost from most automobile junk yards.—SIDNEY POTT.



SETTING A FLY CUTTER quickly and accurately is an easy task if you mount a 3" section of an inexpensive metal scale on a wooden block. Drill a hole the size of the pilot drill through the block. Next cut off enough of the corner of the scale so that it can be mounted on the block with two adjacent edges exactly in line with the center of the hole. To set the fly cutter, simply lower the chuck until the pilot drill is in the hole in the block and the cutter touches the scale. Then move the cutter along the scale to the desired radius and lock it there.—RICHARD SALZER.

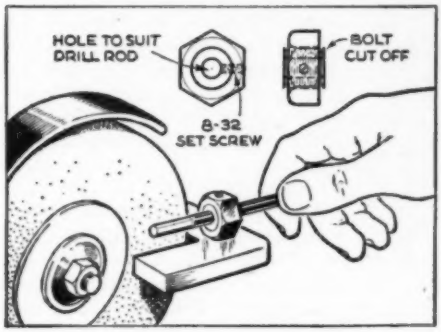
DRILLING ON A DIAMETER is easy with this guide for locating round work on a drill-press table. When pressed down on the work, the guide, held in the chuck, forces round pieces into the exact center position for drilling. It is made of two parts, a ¼" or 5/16" brass rod about 2¾" long, and a 1/16" brass plate about 2½" by 1⅝". Slot the rod and solder it over one side of the plate. Then hacksaw a rough V in the plate and insert the assembly in the chuck of a lathe. With the compound rest set at 45 deg., finish the V, taking light cuts with a sharp, carefully adjusted tool.—H. P.



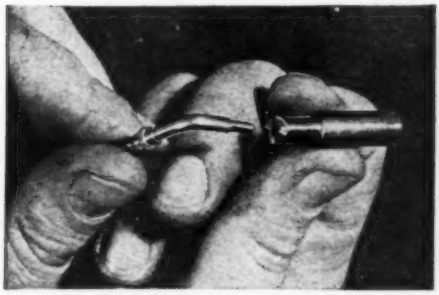


MATCHED CLAMPS, holding several pieces for simultaneous drilling, greatly simplify accurate spotting of holes through all pieces. A set of four clamps, made from steel, brass, or aluminum bar stock, supports work perfectly level on the drill-press table, since the lower legs of all four match exactly in thickness. Short standard screws are used, resulting in a low setup that will not interfere with operation of the drill chuck or feed handle. The drill-press table must, of course, be level.—J. C. MAGEE.

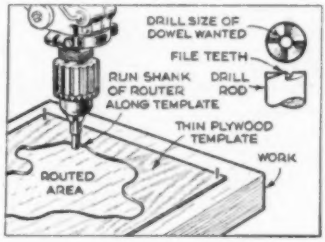
ACCURATE HEXAGONAL SURFACES can be ground on rods by using an ordinary hexagonal nut as a guide. Through one side of a nut just slightly larger than the rod, tap a hole for a set screw. Slip the nut over the rod and tighten in place; if the rod and nut are not concentric, a bushing should be used to center the rod. With the nut on the work table of the grinder, one surface after another is ground. With care, the results are as truly hexagonal as the surfaces of the nut.—Geo. Schrader.



A LATHE DOG of the clamp type will often get a threading die into cramped spaces where an ordinary diestock cannot be used. For accurate alignment, clamp the die firmly in the dog while both are held down on a flat surface. The driving tail of the dog serves as a crank.—C. W. Woodson.



A VERSATILE CUTTING TOOL that turns brass or aluminum pins or dowels and also routs irregular shapes will solve many model-making problems. For dowel forming on brass handrails or model piping (left above), it turns the shoulder down to the desired dimensions after the piece has been bent, eliminating the difficulty of bending a tiny rod and dowel to exact dimensions. Another use is to chuck the tool in the drill press and rout the edges of irregular shapes, running the shank along the rim of a template or pattern (right above). The same tool, used freehand, cuts away the remainder of the routing job.



Made of 3/16″ or ¼″ drill rod, it has a longitudinal hole of the same diameter as the dowel pin desired—1/16″ is a common size. For the cutting face, file four equally spaced teeth in one end. Harden it by heating to a cherry-red color and quenching in salt water. Then temper by heating the shank until a light straw color travels down the shank almost as far as the teeth, and quench in water again immediately. —Herbert Pfister.

Inspection Scope Has Its Own Light

Want to Examine Gun Barrels, Machined Bores, or Pipes? With This Gadget You're Inside Looking Out

IF YOU'VE been hankering to know what the inside wall of your shotgun barrel looks like, this deep-hole inspection scope will satisfy your curiosity. A telescopic instrument carrying its own light, the scope permits interior examination of any tube or hole big enough to admit a flashlight bulb.

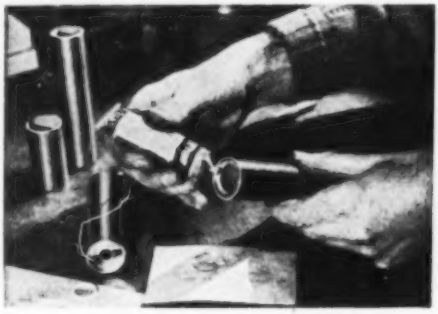
Only inexpensive materials are required to make the instrument. The parts needed are a positive lens, a negative lens, two telescoping cardboard or metal tubes, a rather stiff metal strip about 1/16" by ¼" by 24", the lamp socket from a flashlight, a two-cell flashlight bulb, two flashlight cells, a wall receptacle, a length of lamp cord with plug, a small piece of mirror, and 30" of insulated magnet wire.

The metal strip forms the base of the unit. At one end is fastened the telescope, which does not extend in use within the hole. The mirror is set at an angle near the other end of the base, and the flashlight lamp is behind the mirror.

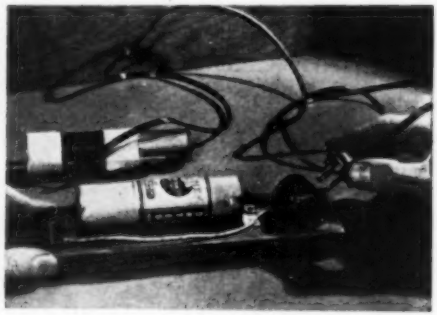
The telescope, an opera-glass type, uses two simple lenses of the sort available from dealers in surplus and chipped-edge optical materials. For the objective, a positive lens of about 148-mm. focal length and 24-mm. diameter is needed, while the negative eyepiece should be of about −74-mm. focal length and 17-mm. diameter. Lenses of similar dimensions may be used, but the diameters should not be too large for convenient mounting, nor too small to provide a good field of view.

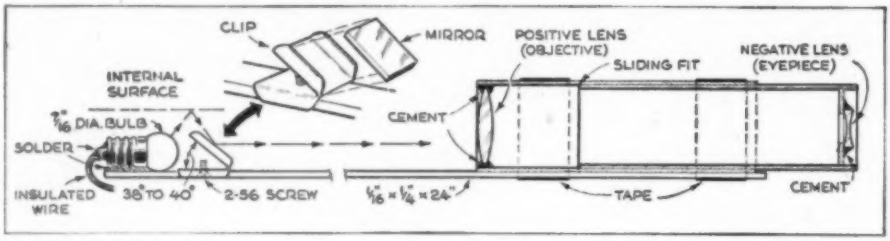
Any two slide-fitting tubes slightly larger

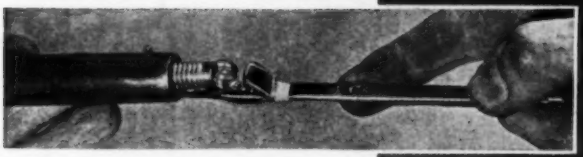
Cellulose cement fastens the telescope lenses in their mounts—the metal ends of cardboard tubes.

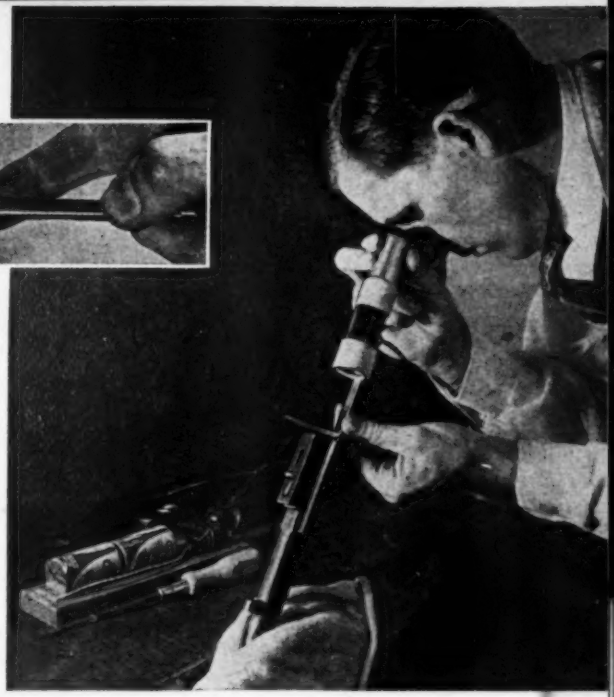


Current for the little lamp behind the mirror is provided by dry cells. The connection is through a plug.









A tiny piece of mirror, set at an angle, keeps out direct glare from the lamp filament (above). At right the scope is used to study the inside wall of a gun barrel.

than the lenses will serve as the telescope body. In the instrument illustrated, cardboard tubes with metal ends—similar to small mailing tubes—were used. The larger tube, 1 3/16″ in diameter, was 4⅛″ long, and the inner tube, in diameter a sliding fit for the larger tube, was 3¾″ long. For mounting, holes slightly smaller than the lenses were cut in the metal ends with a punch and were brought to size with a tapered reamer. The lenses were then fastened with cellulose cement. If cardboard tubes are not available, simple ones can be constructed by wrapping glue-coated paper around a window-shade roller or broom handle. The lenses might be cemented to cardboard rings cut to fit the tubes, and these rings held in place inside the tubes with glued locking rings. Be careful to mount the lenses parallel, with their centers in line. Paint the interior of the tubes a dull black. Then adjust the telescope to focus sharply on objects about 24″ distant, and fasten it in place on the metal base with adhesive tape.

The next part is the mirror, which should be trimmed to fit its support, a strip of sheet metal cut from a tin can. Fold this strip in the middle, forming an angle less than 45 deg., and bend the edges of both sides—one side to hold the mirror and the other to fit around the base. Cement the mirror to the mount and fasten the mount to the base with a 2-56 machine screw. This screw-fastening permits removal of the mirror assembly when necessary to change the bulb.

Directly behind the mirror, at the end of the base, attach the flashlight socket, which should be trimmed of all extra parts, leaving only the threads and the end contact. Solder the threaded portion of the socket to the metal strip, tilting the socket slightly to provide room to insert the bulb. The end contact of the socket is soldered to one end of the magnet wire, which is then strung along the metal strip and fastened in place with adhesive tape. The other end of the wire is spliced to one wire of the lamp cord, while the second lamp-cord wire is attached to the metal strip itself.

Power for the bulb is provided by two flashlight cells, mounted on a small wooden block. Metal clips, again cut from a tin can, hold the batteries in place and serve as terminals. Wires run from the clip terminals to the wall receptacle.

To use the scope, plug it into the receptacle and insert it in the hole you wish to inspect. Focus on the image in the mirror, centering, if necessary, by flexing the metal strip slightly.

This scope should provide a clear, sharp view of interior surfaces magnified two or three times. For better performance, higher-grade optical parts could be used. The mirror, for example, might be replaced with the type known as first-surface, that is, silvered on the front instead of the back, or with a totally reflecting prism like those used in good binoculars. The use of corrected, achromatic lenses in the telescope should add to the brilliance and sharpness of the image. For examination of very small holes a tinier bulb would be needed—miniature lamps such as the "grain of wheat" bulb developed for surgical instruments would let the scope fit into the barrel of a .22-cal. rifle.—WALTER E. BURTON.

Clouds over a low horizon add a feeling of spaciousness to this peaceful country scene.

AUTUMN...Time for Better Pictures

IN THE FALL A FILM FAN'S FANCY TURNS TO OUT OF DOORS

By Don Storing

BRILLIANT autumn often yields photographic opportunities of greater beauty and variation than any other season. The bright and varied colors in nature at this season afford unlimited scope for color shots. Subject matter and long shadows are also ideal for striking black-and-whites.

But, though fall can be your best photographic season, it can also be deceptive. Its clear air and vivid colors may lead you to believe that the prevailing illumination level is higher than it actually is. If you have a tendency to underexpose, this deception can cause disappointments. And other things can happen—things like blurred pictures from a moisture-laden lens, lowered print quality due to decreased contrasts caused by the softening sunlight, and damaged equipment if you neglect to protect your camera from rain or sudden cold.

Try to get colors, varied colors, in your fall color shots, like those in the color reproduction on page 113. Assorted hues are found in colorful clothing, brightly painted

boats, and cottages, farmhouses, and animals as well as in the turning foliage. Yellow and orange leaves will enable you to obtain bright "frames" instead of silhouetted leaf backgrounds so common in black-and-white prints.

The purple haze of autumn can also be very attractive, so don't always expose through a haze-removing filter. Take some photographs with and some without the filter. You may like them all.

Be critical of your light, remembering the limitations of color film. Try various viewpoints until you find just the one that shows the subject off to best advantage.

If you want to minimize strong contrasts, flat front lighting will, as its name implies, reduce them. Most of your color shots will probably require front lighting. And take care not to have too dark a background, such as one of evergreens.

When you want side or back lighting, make sure that the shadow areas are well illuminated by synchro-flash or reflectors. If you employ flash outdoors, be certain that you have blue flash lamps designed for use with daylight-type color film.

In black-and-white photography, unnecessary limits are too often imposed on the choice of subjects when fall arrives. Burning leaves, hunters in the field, shocks of corn, and frosty pumpkins are not the only pictures. Though such scenes are available at no other time, autumn also provides ideal situations for placing a new and different interpretation on familiar subjects.

A cottage in which you spend many a happy summer vacation may be worth going back to in fall for a picture. The place will be deserted and will seem changed; but this may be just the difference that will contribute to an interesting and unusual photograph.

Autumn and summer photography do not present the same problems, and some adaptations of technique may assist in producing more desirable black-and-whites. In some cases changes of equipment may bring better results.

Because the sun is lower, there is less light

A striking example of judicious use of fall lighting. The high horizon emphasizes the foreground detail.

Autumn is picnic time. Your own back yard may furnish such a rustic setting, and a young couple the important human interest.

than in summer and the shadow areas are larger. You may want to consider exposing more for these long shadow regions, since they will occupy more of the view.

Tend toward overexposure if you feel uncertain, but be on the alert to change your customary speed and aperture settings as circumstances dictate. Take along a tripod. Nothing is so disconcerting as running into just the landscape you have been looking for all day—at twilight and without a tripod.

Landscapes tend to be monotonous in composition unless certain precautions are observed. Black-and-white fall landscapes are often better when contrast is introduced, such as including an arch, a doorway, or the overhanging bough of a foreground tree as an appropriate "frame" for the scene. When these "frames" are silhouetted, they add interest, depth, and contrast

Dry shocks of corn and barren fields yield prints possible only in autumn, but don't feel you are limited to seasonal subjects.

When shadows are long in fall, outdoors calls with many scenes like this. Use of a yellow filter brings out the cloud pattern, and a silhouetted tree in the foreground adds depth for a fine study.

Pattern shots, too, can be found at this time of year, especially if the camera fan has an eye for possibilities like that below. A low camera angle provides a background of sky.

The correct use of filters can also be valuable. A yellow filter will hold back the blue light from sky areas to give a natural rendition of clouds. Greater-than-normal sky contrast may be obtained by exposing panchromatic film through an orange or red filter. Such "overcorrection" for landscapes will yield striking contrasts, making your prints pack more wallop and "carry" farther.

Placing the horizon low often increases the effectiveness of outdoor composition. At other times the foreground may require the major space. It is rarely good to have the horizon at the middle.

Though the temptation to take a picture of an entire valley is strong, limit your view to a more intimate study. There are exceptions, of course, but the "big scenes" are all too often disappointing in the print.

Photographs of trees are always appealing, and tree photography is a challenging hobby full of surprises and fun. The primary problem is one of isolating your tree without resorting to an ax.

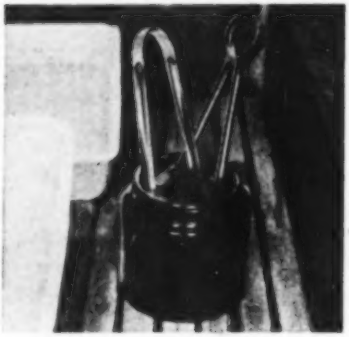
When trees are scattered, a low camera angle may separate the selected subject from those behind it, lowering the horizon and providing a subdued background of sky and clouds. If the problem cannot be met by camera angle, use a wider aperture and a faster shutter speed to soften distant details by throwing them out of focus. The shallower depth of focus emphasizes foreground and subordinates background.

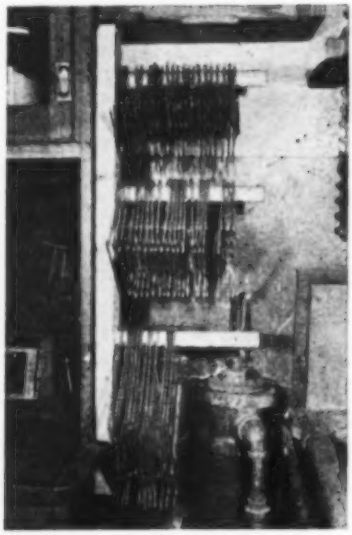
The haze of fall frequently creates ideal black-and-white mood situations. Distant views blend away into misty backgrounds sometimes, while at others sudden shafts of sunlight strike through to make patterns that most photographers dream of but seldom have a chance to catch on film.

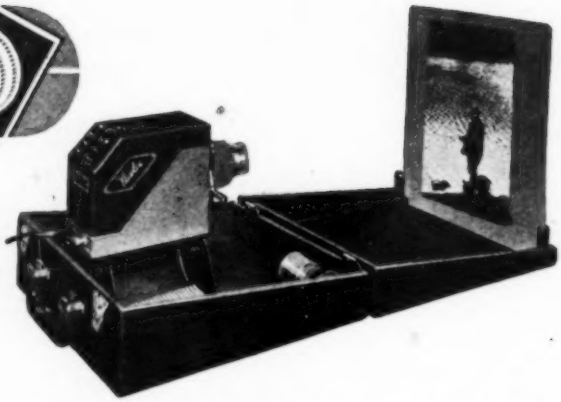
Some of the most enthusiastic fall photographers are occasionally disappointed. But if proper attention is paid to the care of your equipment and changed demands, autumn can be your most successful season.

PHOTO IDEAS and EQUIPMENT

PRINT TONGS will not drip developer all over your darkroom bench if you keep them in a glass jar. A jar that contained chemicals for 1 gal. of developer holds the tongs upright, handy for immediate use yet out of the way. Some fresh water in the jar rinses them at the same time, removing developer or shortstop solution.—THANE L. BIERWERT.

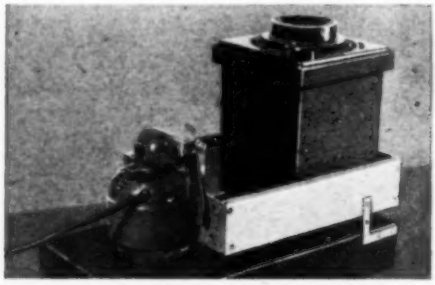






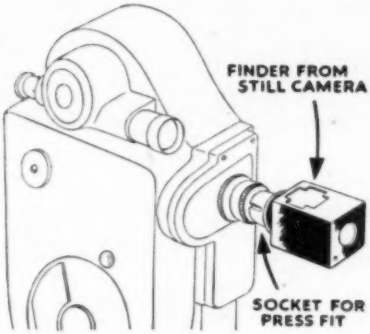
A NEW PROJECTOR for 35-mm. and 2″ by 2″ slides need never be removed from its case—even the screen can be set up at one end. The use of a short-focus lens gives large pictures without a long throw. Condenser lenses that do not have the conventional spherical curvature, used for the first time in an American-made projector, add sharpness and brilliance, claims the manufacturer, Viewlex, Inc., Long Island City, N. Y.

AUTOMATIC AGITATION. Two radio chassis and the motor from an oscillating fan were incorporated in this homemade film-tank agitator. The smaller chassis is pivoted at one end on angle brackets attached to the base chassis and tilted by the reciprocating arm.—GEORGE O. SMITH.



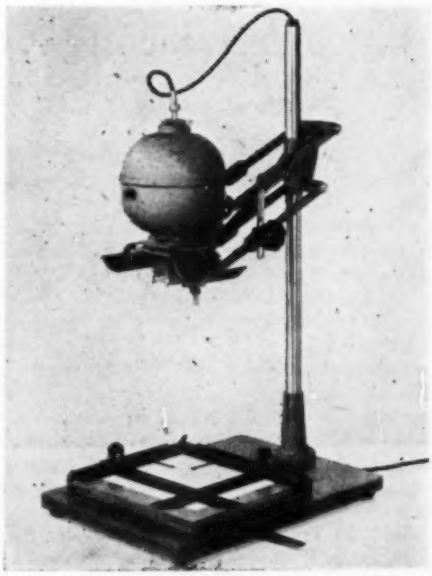
CUT-FILM HANGERS can be stored neatly and conveniently on a simple wall rack made from a 36″ piece of two-by-four and three lengths of 1½″ closet pole. In cutting the poles, allow 3″ for each six hangers. Fit poles into holes drilled in the board at an angle, fastening with finishing nails. Space the holes according to hanger size.—T. L. B.

BIG EYE. This 255-mm. lens, an f/2.3 Pan Tachar fitted with a special aluminum mount to adapt it to a 4″ by 5″ Speed Graphic, photographed Ordnance Department tests of rocket trajectories and flight characteristics under very poor light conditions. Since the mount replaced the standard lens board, all exposures were made with the focal-plane shutter. The designer of the big, high-speed rig, Zev Pressman, of the Alleghany Ballistics Laboratory, Cumberland, Md. is shown using it.—G. C. MacDonald.

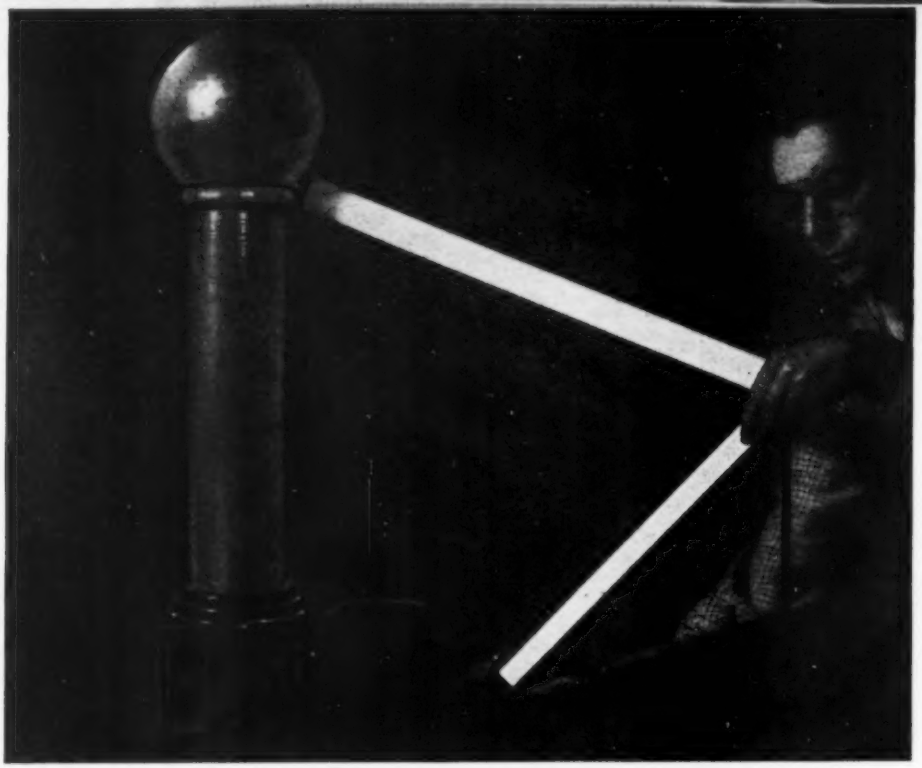


OFF-CENTER MOVIE TITLES can be avoided by using the waist-level view finder from a folding still camera to line up your work. Equipped with a socket to permit a press fit over the lens, the waist-level finder ends all parallax error.—C. M. Huntley.

SIMPLIFIED ENLARGING is the promise of the postwar Leitz Focomat Ib, which has automatic focusing, conveniently located controls, large knobs, and a housing that tilts for quick access to the film and condensers. Automatic focusing through a range of 2½ to 13 diameters is provided by parallelogram supports, with helical focusing available for greater enlargement. Although designed for 35-mm. film, the Focomat takes negatives up to 4 by 4 cm. E. Leitz, Inc., New York, is the maker.



PHOTOGRAPHIC SOLUTIONS filter themselves, without supervision, in the Viking Filtorette. To remove sediment and dirt from a solution, it is poured into one bottle of the unit, which is connected to the second bottle with a special cap, vent tube, and filter disk, and the unit is inverted. Filtering is then automatic. Viking Products, North Hollywood, Calif., make it.



Static electricity escaping from the generator will light a chain of fluorescent tubes held end to end.

Lightning in Your Hand

EXPERIMENTAL MODEL OF A VAN DE GRAAFF ELECTROSTATIC GENERATOR CAN DELIVER OVER 100,000 HARMLESS VOLTS

By Loren W. Gay

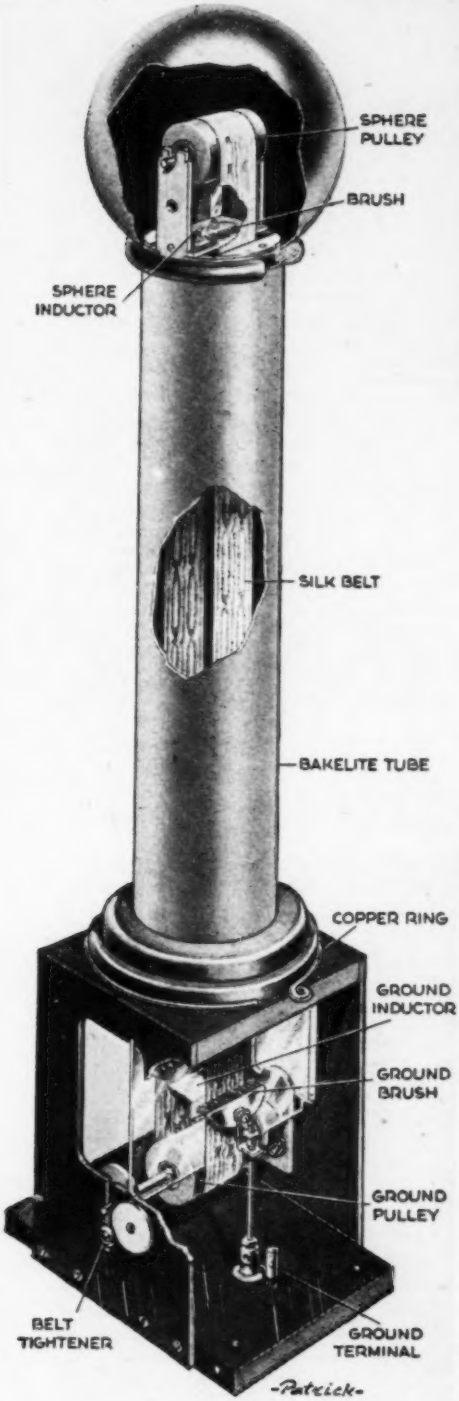
NUCLEAR physics, the unpredictable baby of the sciences, is about 50 years old. For the first two thirds of its short life it crawled patiently along on all fours. Then, without bothering to walk, it started to run. Just where it's running to, no one knows, but it has already revolutionized man's conception of his universe without even stopping for breath.

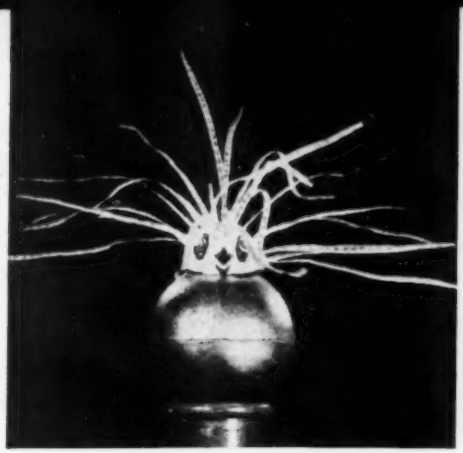
One of the mileposts in this swift race was the original of the electrostatic generator shown here. Neither surprising nor dramatic in its origin, the device was invented simply because it was needed: physicists wanted a controlled source of high-voltage D.C. in order to bombard the nucleus of the atom.

In 1931, Dr. Robert J. Van de Graaff went back to first principles to build a machine capable of delivering nearly 2,000,000 volts. Instead of rubbing amber and silk as the Greeks had done 2,000 years before, he revolved an endless belt in contact with metallic brushes.

The remarkably powerful model described in this article was designed chiefly as a laboratory-demonstration instrument. It is very simple in construction, and its exposed lower section permits a clear view of operation as well as effects. Before starting to build, procure the roller shafts, ball bearings, and the bakelite tube. If these vary from the dimensions given, you may have to alter some of the other specifications so that the parts will fit together properly.

Hard composition board was used for the two sides of the ground-pulley housing. Saw two pieces roughly to size, clamp them together, and drill and jigsaw the windows,



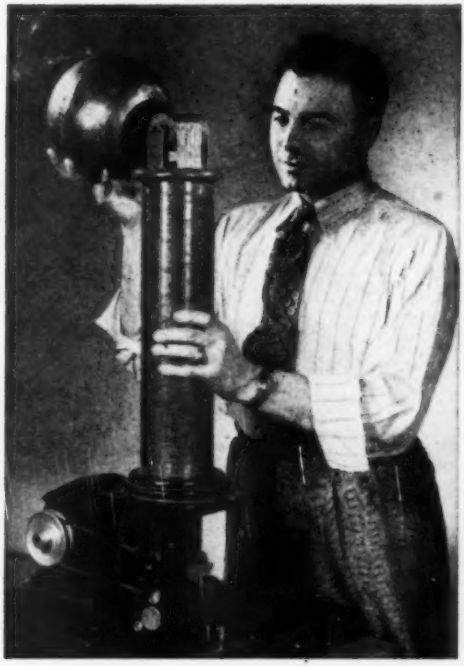


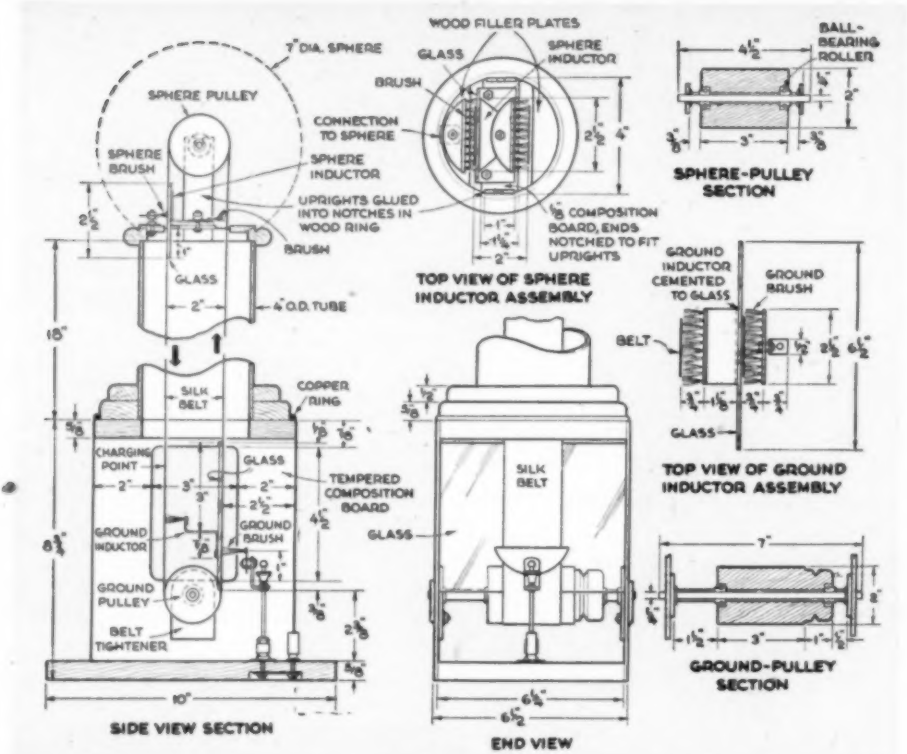
A papier-mache octopus looks friendly enough as he spreads his paper tentacles in the electric breeze.

slots and holes in both at once to insure perfect alignment. Slots for the pulley shaft should make a snug fit to prevent vibration, and the slots that will hold the ground-inductor glass must be cut so that the glass will be perfectly parallel to the silk belt and in light contact with it. It may be easiest to cut the glass first and fit the slots to it.

Cement and screw the base, sides, tube,

The sphere should rest snugly in the groove of the upper ring. Smooth the surface as much as possible.





Construction details given here are based upon the actual model, but many of them may be varied to suit available materials. Output is governed chiefly by the length of the tube and the diameter of the sphere.

and the two lower wood rings together. The belt tighteners and the uprights for the sphere pulley are also made of composition board clamped together and finished in pairs.

For the rollers, use a good dry wood that is not subject to warping or cracking. Rough them on the lathe, then screw to the faceplate a scrap piece of 1" stock, and in it turn a hole that will make a tight press fit on one end of the roller. With the pulley chucked firmly in this hole so that you can work on the free end, turn a centered opening just large enough for the ball bearing to be pressed into place. Bore the shaft clearance hole part way through, using a skew chisel. Repeat these operations on the other end, and complete the shaft hole with a drill.

Prepare the other pulley in the same way. Test both rollers to make sure that they run true. Press the bearings and shafts in place, and clamp one shaft tight between the lathe centers. Belt the pulley to a motor so that it will spin on its bearings, and carefully turn the wood down to a uniform diameter of 2". Turn a groove in the ground pulley for the driving belt; the sphere roller, of course, needs no groove. If the pulleys are out of true in any respect, it will be worth while to discard them and try again. Quality ball bearings good for a speed of 6,000 r.p.m., with an outside diameter of ¾", are recommended.

When assembling the pulleys on the shafts and on the machine, use washers and short pieces of metal tubing to space them out between the supports. Align the rollers with extreme care, and cement the upper ring on the tube.

Pure silk ribbon would be the ideal choice for the belt, but you'll probably have to settle for rayon. Set the tighteners to allow ½" take-up, place the ribbon around the pulleys, and cut it to size, allowing about ¼" lap. Remove the belt, cement the ends together, and clamp the lap between blocks overnight.

When the mechanical parts are in satis-

factory running order you can proceed with the electrical parts—the brushes and inductors. Inductors are made of sheet aluminum or similar metal, cemented to glass plates. For the sphere inductor, cut a 2¼″ by 2½″ piece of aluminum, bend it to a right angle, and cement it to a 2½″ by 3¼″ sheet of thin window glass. Both are then cemented to the edge of a piece of composition board which is slotted to fit between the pulley-supporting uprights. Position this piece so that the glass plate will be parallel to and make light contact with the belt. A brush, which must make electrical contact with the inductor, is bolted to the same composition-board strip, and touches the ribbon at the opposite end of the roller. The sphere brush completes the upper assembly; it is located directly behind the inductor and is separated from it by the ribbon and glass.

To assemble, install the sphere brush, and drop a loop of the belt through the bakelite tube; then slip the inductor assembly in place between the uprights, and place the sphere pulley and shafts in the retaining slots. Insert the ground pulley through the belt, and adjust and tighten to run true. The ground inductor and its brush are made in one piece and cemented to the lower glass plate, which is placed in slots in the housing and held firm by wood disks screwed to the case to overlap the edges of the glass.

Brushes are made of sheet aluminum or copper (medium-size variable-condenser plates will do nicely) and short pieces of extraflexible stranded-copper wire or tinsel. Drill an even number of small holes parallel to one edge and spaced about ¼″ apart. Loop a length of the wire through each pair of holes, and bend the metal back on itself to clamp the wire in place. Trim the edges to a straight line. Brushes should be cut to come as close to the belt as possible without rubbing or catching appreciably.

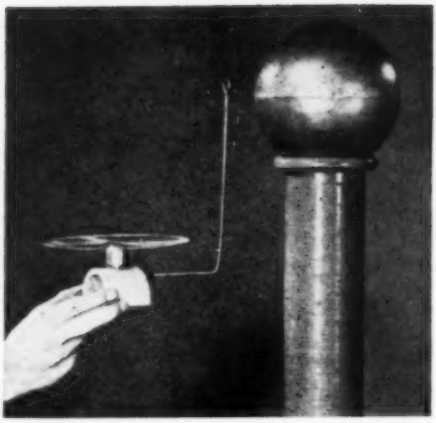
The sphere is a 7″ metal map globe with an opening 4″ in diameter cut in the bottom. File the edge of the opening so that the globe fits the groove in the upper ring; if the fit is good, no other fastening is needed.

Shellac or varnish all wooden parts of the machine; avoid paints, since some pigments are metallic and will reduce efficiency. When the generator is ready for trial, screw it to a solid base and belt the lower pulley to a ¼-hp. motor so as to drive it at about 3,000 r.p.m. Connect the copper ring and the ground brush or its terminal to a good external ground. *[Turn the page.]*

Adjust the belt tighteners until, at full speed, the ribbon runs smoothly in the center of both pulleys.

With the motor running, touch the belt lightly at the "charging point" with a rolled edge of celluloid or photo negative. Friction will knock free some of the electrons in the belt, imparting a positive charge. The missing electrons, however, are immediately replaced by the inductor brush, creating a potential between the latter and the ground brush. Between these oppositely charged plates, the glass acts somewhat in the manner of the dielectric of a condenser. Free electrons are attracted from the ground onto the ribbon, which promptly carries the negative particles upward through the tube and into the sphere. Three or four complete revolutions may be necessary to build the charge on the sphere inductor to its saturation point, after which most of the electrons are carried around to the sphere brush where, by repulsion of the sphere inductor, they are kicked off into the metal globe. The celluloid charging sheet may then be removed and the generator will continue to build its own cycle.

Once the sphere is fully charged, a number of interesting effects may be observed. Some are illustrated on these pages; others may come to you as a bit of a surprise. If you venture close to the generator when it is in proper operation, the tingling sensation you may feel will probably be due to hair standing up on your head or forearm. You can draw a spark to your finger or to any metal object held near the sphere. In a darkened room you will be able to see the static electricity streaming from the ground brush onto the belt, and from the ground inductor up over the glass plate to the belt, or from one side of the belt to the other.



Carried down the stiff upright wire to the pivot, static electricity drives the pin wheel briskly.

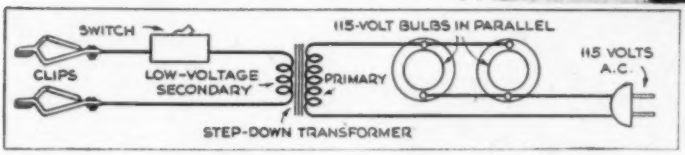
Measurement of actual voltage is extremely difficult, so no attempt was made to obtain a proper rating of this unit. Under favorable conditions the spark effects that are observed suggest an output in excess of 100,000 volts.

Favorable conditions, by the way, include a dry climate, since moisture encourages the charge to leak off into the atmosphere. If you live in high, dry territory, you can get results the year round. If not, you'll have to do your experimenting when the weather man gives you the nod, or when winter's steam heat cooks the moisture out of the air.

Smoke-filled jars can be cleared quickly. Pins soldered to the lower half of the ball-tipped rod dissipate the charge; the electrified smoke particles repel each other, and are deposited on the walls of the jar.

Self-Adjusting Circuit Makes Transformers Safer

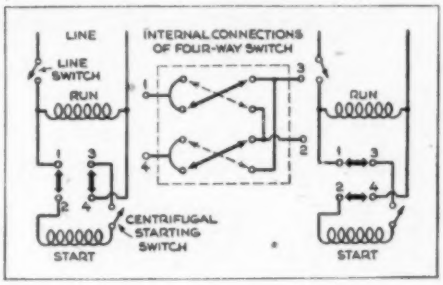
WITH this circuit, you can make it safer for a young child to play with low voltage A.C. toys that require a stepdown transformer. If the child accidentally shorts the secondary, the risk of burning out the transformer is greatly reduced because the two 115-volt bulbs installed in the primary side limit the current. Usually, one 25-watt and one 60-watt bulb will do the job.—R. C. H.



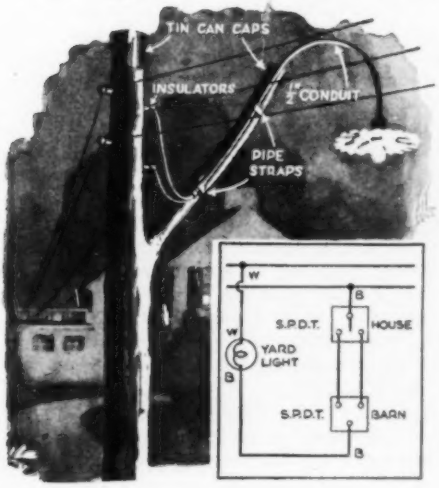
Four-Way Toggle Switch Employed to Reverse Induction Motor

A SIMPLE method of reversing an induction motor is illustrated in the accompanying diagram. It involves use of an ordinary four-way toggle switch, which is, in effect, a D.P.D.T. switch.

Since the switch carries current only during the starting period, it need not be one having a heavy-duty rating. Even if the motor is running, the reverse switch may be thrown and no damage will result since the starting winding is open. The regular line switch is used for "off" and "on".—H. J. W.



Yard Light and Electric Wires Supported on Tree-Fork Pole



WHILE on a recent visit to a farm, I came across a novel idea for a yard light and a supporting pole for the electric wires between the house and barn. The pole, about 8" in diameter at the base, had been cut so as to retain the first major fork of the original tree. One prong provided a mount for a light that could be operated either from the house or barn, as e diagram shows. The other supported the wires. Painted tin cans were fitted snugly over the fork ends to prevent decay.

The light consisted of a reflector and socket fixed to a short length of ½" electric conduit bent in a J shape and attached to the pole with two ½" pipe straps. A bushing screwed on the other end of the conduit prevented the metal from cutting through the insulation. Knob-type insulators held the wires.—JOHN W. LA LONDE.

To check the frequency of your signal, separate your receiver and transmitter, and listen in on yourself.

GET STARTED IN HAM RADIO WITH THIS

Midget 80-Meter Code Transmitter

By CLINTON E. CLARK

A RADIO "station" hardly bigger than a shoe box is an ideal rig in many respects. If you've just obtained your license, you can use it to get on the air at the cost of a few dollars and even fewer hours. On the other hand, if you're an old timer operating a more elaborate phone transmitter, here's a quick and inexpensive way to renew your acquaintance with the fast-fingered hams who keep the code bands clicking.

Despite its size, this transmitter is capable of real performance. Just bear in mind that the 80-meter band is crowded with high-powered outfits, so you'll have the best chance of getting through during the relatively quiet hours.

For the baseboard, take a piece of ¾" by 5" by 7" wood and center the tube socket and six-prong crystal holder on a line 2½" from the rear. Raise the socket on ⅜" sleeves or small insulators, and drill a ⅜" hole under it to pass the filament and cathode wires. Fasten a six-lug terminal strip along the rear edge of the wood.

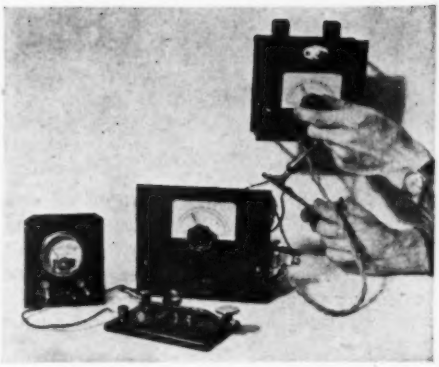
To make the plate coil, L3, wind 38 turns of No. 20 D.C.C. wire on a 2" dia. form, spacing the turns to a length of 3". This coil is center tapped, as indicated in the diagram, and has a two-turn coupling coil wound over it. The antenna coil, L4, is made in the same way except for the omission of the center tap. Mount the plate coil alongside the tube socket on a pair of standoff insulators.

The antenna tuning unit is the electrical counterpart of the coil-condenser circuit in the transmitter. Front and rear panels are made of ⅛" by 6" by 6" composition board separated by ¼" dowels 3" long.

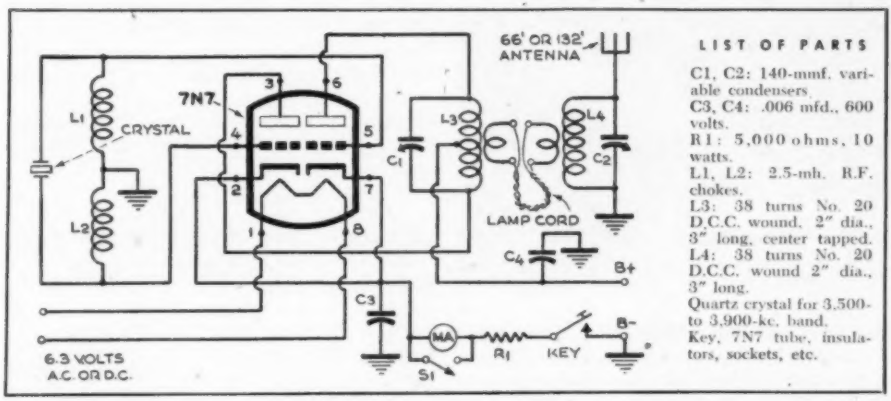
When the wiring is completed, connect the transmitter to a power supply capable of delivering 250 to 300 volts to the plate, and 6.3 volts to the filament. Shunt a 0-to-200 milliammeter across the keying circuit as shown in the diagram, and, with the tube

lit, apply plate power by closing the key. The meter needle should rise sharply, but as the plate circuit is tuned to the operating frequency of the crystal, the meter will register a downward dip.

The next step is commonly called "loading the antenna." Connect twisted lamp cord between terminals *y-y* of the transmitter and antenna unit, hook up the antenna and ground, and rotate the antenna-tuning condenser. With the key closed, the meter needle will rise when the antenna is in resonance with the transmitter. After loading the antenna, it is sometimes necessary to retune the transmitter slightly. Another method is shown at the right. The bulb should be brightest when the transmitter is tuned to resonance, but the light decreases as the antenna is closed.

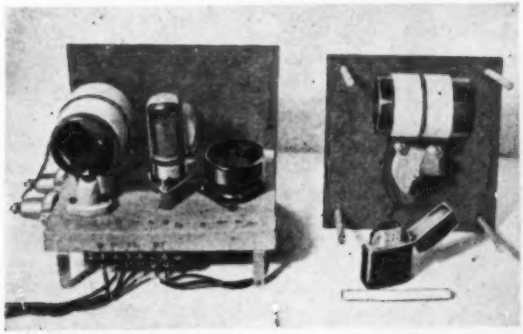


An alternative antenna-tuning method consists of connecting a loop of wire to a neon or Christmas-tree bulb, and holding the loop near either end of the plate coil. Energy in the coil lights the bulb.

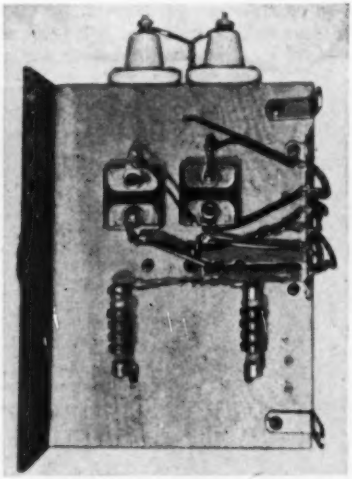


LIST OF PARTS

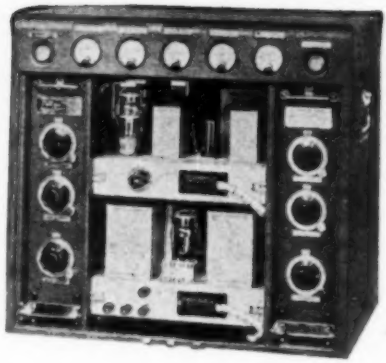
C1, C2: 140-mmf. variable condensers.
C3, C4: .006 mfd., 600 volts.
R1: 5,000 ohms, 10 watts.
L1, L2: 2.5-mh. R.F. chokes.
L3: 38 turns No. 20 D.C.C. wound, 2" dia., 3" long, center tapped.
L4: 38 turns No. 20 D.C.C. wound 2" dia., 3" long.
Quartz crystal for 3,500- to 3,900-kc. band.
Key, 7N7 tube, insulators, sockets, etc.



Legs for the transmitter are formed by two metal angles in back, and the bottom of the panel in front. The two stand-off insulators at the far left support the link-coupling coil, which is made of two turns of insulated wire around the center of the plate coil. Underneath the baseboard, mount the two R.F. chokes, the two by-pass condensers, and the 5,000-ohm cathode resistor, as shown at the right.



NEWS IN ELECTRONICS



LOW-POWER COMMUNICATION for airports is provided by a complete 50-watt radio station made by Aireon Manufacturing Corp., of Kansas City, Kans. The transmitter, right, and its associated receiver are crystal controlled and tuned by push buttons over several frequency ranges.

The little microphone, at right, provides ultra-faithful program pickup.

A TINY MICROPHONE, above, recently developed by Bell Telephone Laboratories, approaches the ideal size for a point pick-up device. Phase distortion due to sound waves striking different portions of the diaphragm is practically eliminated by its small diameter. It is generally used with the amplifier shown above.

MAGNETIC STORMS, extremely prevalent along the direct route from New York to Moscow, will be by-passed by a new radio relay station built by RCA Communications, Inc., in the International Zone at Tangier. The relay station provides a means of insuring uninterrupted service between the two world centers when short-wave signals are blocked by sunspot-generated disturbances. The new route is 1,300 miles, or 1/140 second, longer than the old.

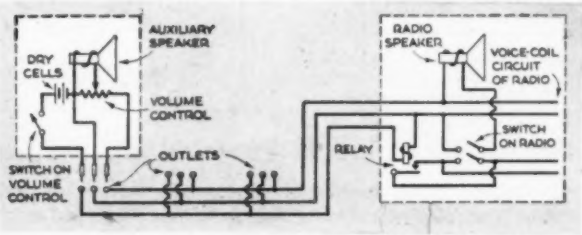
COAXIAL-CABLE CONNECTORS make it easier to obtain water-tight joints on feed lines for high-frequency antennas. Introduced by Barker & Williamson, of Upper Darby, Pa., the connector, right, is made of aluminum with steatite insulation. Weatherproof cement, rubber tubing, and a set of screws are supplied with each unit.

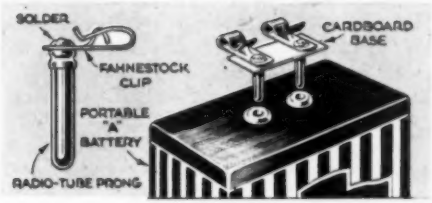
MUSIC FOR TWO BITS will shortly be offered to hotel guests by Radio-Matic of America, Inc., who will distribute this coin-operated General Electric radio. A quarter in the slot provides two hours of entertainment; since the electric timing device operates only while the radio is on, the two hours represents actual listening time. Now you'll be able to save money by switching off the commercials.

PIPED PROGRAMS. You can listen to your console radio in any room in the house with the remote pickup and control system shown below. A portable speaker, plugged into the circuit wherever convenient, has a volume control and an on-off switch that controls the radio.

The only changes necessary in the radio itself are the installation of a new power switch with an extra pole, and a relay for remote on-off control. This relay, of about 1,000 ohms resistance, should operate on two or three flashlight cells. Low-voltage conductors such as bell or magnet wire will do for the house circuit. The portable speaker—more than one could be used—is a permanent-magnet type; mount it in a housing with a combined power switch and volume control of 1,000 to 5,000 ohms resistance. This adjusts the remote speaker without affecting the radio—WILLARD ALLPHIN.

You can listen to your best radio from any room with this system.

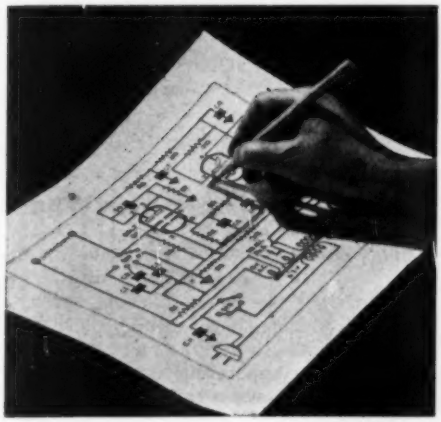


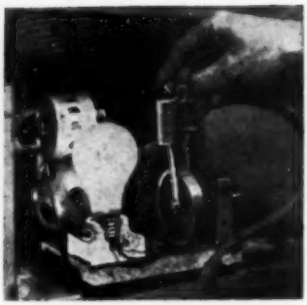


PLUG-IN ADAPTERS. Prongs from burned-out radio tubes secured to a cardboard base enable you to connect plug-in type portable radio batteries anywhere. Three prongs are needed for a "B" battery having a 22-volt terminal. Make sure the leads can't be accidentally shorted.—C. E. WARD III.

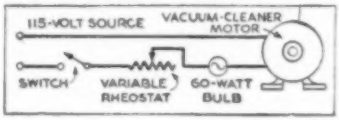
INSULATING GROMMETS are quickly made from slip-on pencil erasers. Drill the hole right through and round off corners on an emery wheel. Cement will hold it on the wire.—AL. M. LINDNER, JR.

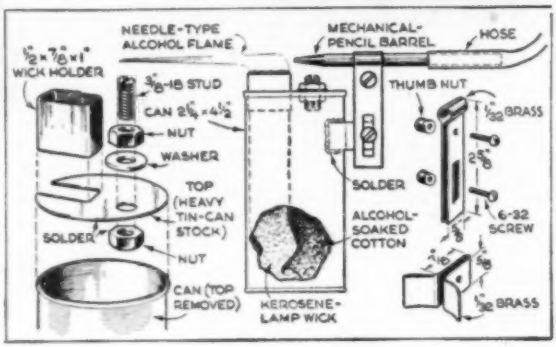
LEST YOU FORGET which part of a complicated wiring job has been finished, run a colored pencil over the lines on the circuit diagram as you wire in each one. Then there is no need to trace wiring to learn what is left to do. It's also a help in preventing wiring mistakes.—JOHN BORODICH.





The throttle valve of the steam engine controls air flow. A lamp in series with the motor reduces speed.





Alcohol Blowpipe Is Powered by Miniature Air Compressor

INTENSE heat, concentrated in a needle of blue flame, is instantly available from this tin-can lamp and blowpipe. Ideal for delicate soldering, the torch will also handle jobs too big for a 75-watt iron. With a charcoal block and asbestos-paper shields, it will even silver-solder small parts.

Cut the top off a tin can and cut a disk of extra-heavy tin-can stock to replace it. Punch a 3/8" filling hole in the disk, solder a 3/8" nut underneath, and in a slot solder a wick holder made from tin-can stock. Pack the can with cotton and lamp wicking and solder the new top in, having first inserted a stud and top nut to keep the under nut from loosening while hot.

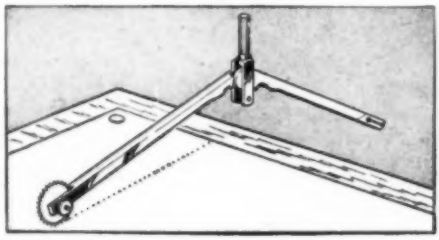
For the blowpipe use the barrel of a mechanical pencil. A bracket soldered to the can and another bent around the pencil permit adjustment to obtain the best flame.

Attach a length of windshield-wiper hose, trim the wick to about 1/16", and fill the can two-thirds full with alcohol. Light the wick and adjust the nozzle until gentle, steady blowing in the tube produces a pointed blue flame about 3" long.

For prolonged work I've rigged up a single-cylinder, single-acting model steam engine to be driven backward as an air pump. A 5-gal. can acts as an air dome to level out pulsations, while a discarded vacuum-cleaner motor drives the "compressor." To hold the motor to a few hundred r.p.m., wire several resistors in series with it.—F. R.

Compass Used as Pattern Wheel

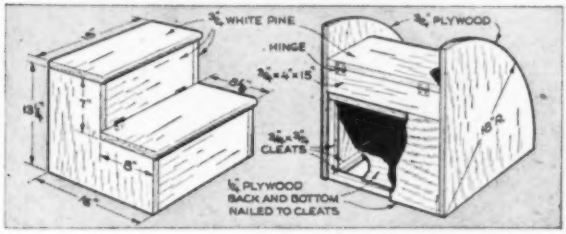
BY REMOVING one of the small screws from a drafting compass and inserting a watch or clock gear of suitable size, a pattern wheel or stitching spacer can be made. The screw is replaced to serve as an axle for the gear, and the compass legs are spread to full width.—G. E. HARRINGTON.



Combination Steps and Toy Chest Help Child to Help Himself

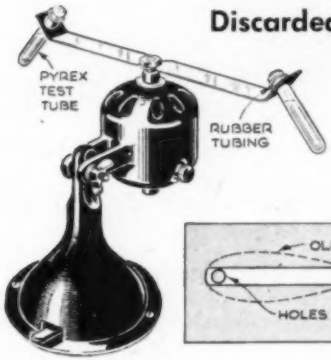
INDEPENDENCE in a child in such things as washing hands and brushing teeth is developed by providing a means for the youngster to reach the wash basin. This two-step stand is also a small chest in which can be kept toys, pajamas, or towels.

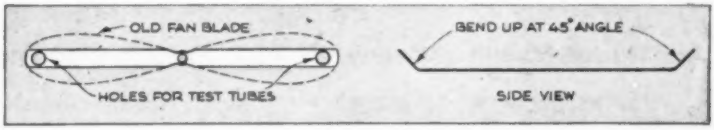
Waterproof ¾" plywood is ideal for sides as it won't warp even in a steamy bathroom. Fill the edges to provide a smooth surface for an enamel finish. Steps may be cut from solid ¾" or 1" pine and are hinged. The back and bottom may be ¼" plywood.—RALPH S. WILKES.



Discarded Fan Converted to Laboratory Centrifuge

AN ELECTRIC fan with the blade flattened, cut down to a strip, and drilled and bent at the ends makes an efficient low-speed centrifuge. Fit rubber washers on the test tubes before inserting them, and bolt the fan down with the shaft in a vertical position.—ALOYS L. TAPPEL.





Flat Paint on Radiators Increases Heat

BETTER radiation, and consequently more heat, can be coaxed from your radiators this winter by repainting with flat wall paint. A bulletin from the National Bureau of Standards states that nonmetallic flat paint is 16⅔ percent more effective on radiators than metallic paints such as bronze or aluminum. And to make it easier, so you won't have to scrape off old paint, only the top coat influences radiation.

The color of the paint also has its effect on heating efficiency, with white giving off most heat. Cream, red, gray, yellow, black, aluminum (color only), and brown then follow in the order named.

ADSORPTION is the word!

And Though It's Still a Mystery, Chemists Make It Work Modern Wonders

By KENNETH M. SWEEZEY

EVERY time we use blotting paper on ink, talcum powder on a grease spot, or the white of an egg to settle coffee grounds, we evoke the mysterious property of *adsorption*. Although the "why" of this phenomenon is imperfectly understood, its practical application produces amazing results in industry.

Unlike *ab*sorption, which means the taking of one substance into the body of another (like water into a sponge), *ad*sorption pertains only to thin concentrations of one substance on the surface of another. As it is a purely surface effect, adsorption is observed best in substances that are finely divided or highly porous. Charcoal, silica gel, activated alumina, and fuller's earth are among the most important adsorbents. By trapping specific substances on their surfaces, they remove unwanted colors, tastes, and odors from drinking water, food products, chemicals, and drugs. In like manner they help recover gases and solid and liquid chemicals that otherwise might be lost in certain industrial processes.

Activated carbon and silica gel (a porous form of silicic acid made by reacting hydrochloric acid with sodium silicate) are used to trap odors and moisture in air-conditioning systems and to dry the air in packages of machinery. Small containers of these adsorbents can sidetrack undesirable food smells that sometimes are found in the home refrigerator.

Surface catalysts owe their properties to adsorption. By catching molecules of two or more different substances and holding them tightly together, they promote reactions

Poisonous gases and obnoxious odors can be trapped by adsorption on the surface of activated charcoal, used in gas masks. On the facing page, the bad-egg stench of hydrogen sulphide is held by powdered charcoal in the large tube and can't be detected at the outlet, but disconnect the generator and heat the charcoal, as above, and the odor is immediately apparent.

that would not occur in the ordinary association of these substances. Synthetic ammonia, sulphuric acid by the contact process, and hydrogenated oils are a few of the industrial products that are made possible by adsorption.

Most war gases and many odors such as those of garlic and cabbage can be trapped by adsorption on charcoal. You can easily prove this by removing from circulation a gas that, as normally experienced, makes a remarkably obnoxious odor.

Set up a simple hydrogen sulphide generator by dropping 1 gram of iron sulphide into a flask, covering the bottom with ¼″ of water, and stoppering with a two-hole stopper—one hole provided with a delivery tube bent at right angles and the other to admit a medicine dropper. Your adsorption apparatus may be a 1″ by 12″ glass tube filled with granular or powdered charcoal held at each end by a wad of loosely packed absorbent cotton. Clamp this tube horizontally to a ring stand and connect one end through a one-hole stopper to the gas generator. Fit a similar stopper in the other end with a bent outlet tube.

The best charcoal for gas masks is made from coconut shells. Charcoal from fruit pits, walnut shells, hardwood, and even hard coal has pinch-hit—effectiveness decreasing in the order given. All are made tremendously more efficient by *activation,* generally a process of heating in steam and air to drive off adsorbed hydrocarbons.

For your experiments, almost any powdered or granulated charcoal will do. If it has not been activated, it can be made partially so by heating to redness in a crucible and then cooling just before use.

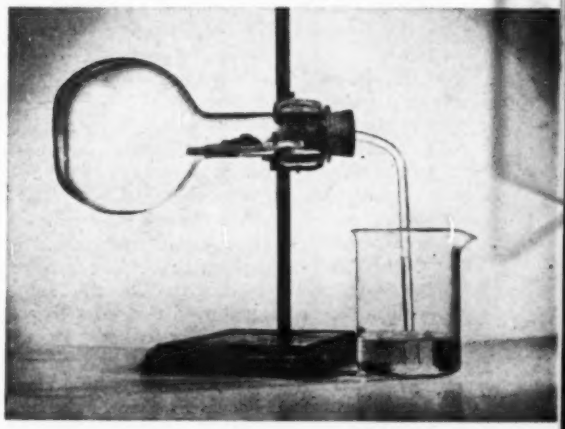
Fill the medicine dropper with concentrated hydrochloric acid and squeeze it into the flask through the hole in the stopper. Refill, squeeze again, and then press the dropper in tightly to seal the hole. The acid will react with the iron sulphide to form hydrogen sulphide.

After the gas has been generated for a minute, waft it from the outlet tube toward your nose. If your charcoal is good and the setup correct, you will smell nothing.

Disconnect the flask and plug that end of the charcoal tube; then heat the tube gently with an alcohol flame and waft some more of what issues toward your nose. The warmed charcoal releases the adsorbed stench.

To find out how charcoal clings more tenaciously to some gases than to others,

Charcoal here adsorbs ammonia gas in a flask. The resulting partial vacuum draws up oil in the tube.



Put a few drops of ink in a glass of water and add a little alum and household ammonia. The gelatinous precipitate of aluminum hydroxide formed adsorbs the color and carries it down as it gradually settles.

repeat the experiment with other gases. Laboratory tests indicate that activated charcoal can adsorb seven times its own bulk of hydrogen, 25 of oxygen, 64 of carbon dioxide, 200 of ammonia, and 300 of chlorine.

The adsorbing power of charcoal can also be demonstrated visually. Fill a flask with ammonia gas by pouring a little strong ammonium hydroxide in the bottom, letting it stand a few minutes so the ammonia fumes will drive out the air, and then inverting to pour out the liquid and stoppering while the flask is still inverted. Mount the flask horizontally and place nearby a new stopper with a bent glass tube and a beaker of oil.

Remove the first stopper, insert a folded strip of paper containing a heap of powdered charcoal, and put in quickly the stopper with the bent tube. As the charcoal adsorbs the gas, it produces a partial vacuum that causes the oil to rise in the tube.

Charcoal takes iodine out of solution, and the liquid will come through a filter amazingly clear.

Adsorption of one chemical substance by another finds important use in dyeing. Colors that ordinarily will not be retained by a textile can often be made to stay by first treating the textile with an insoluble chemical that adsorbs the dye. Aluminum hydroxide is such an adsorbent.

You can demonstrate the effect by adding a few drops of a suspension of indigo or alizarin or ordinary black ink to water in a tall glass. Next, dissolve ¼ tsp. of common alum in the water, and then stir in ½ tsp. of household ammonia. Clumps of colored matter will appear with clear spaces between them, and they will settle gradually, leaving the upper part of the water clear. What happens is that the alum (potassium aluminum sulphate) reacts with the ammonium hydroxide to form a gelatinous precipitate of aluminum hydroxide. This adsorbs the coloring matter, which is carried down as the precipitate settles.

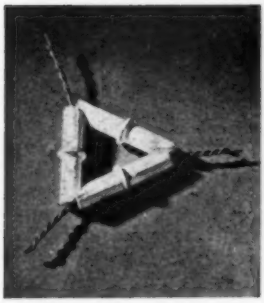
Adsorption is one means by which iodine is recovered from brines from petroleum wells and from brines worked up for salt. Color a glass of water strongly with tincture of iodine and stir in thoroughly 1 tsp. of activated charcoal. Then filter the solution. Clear water will come out, and the iodine will remain bound to the charcoal. The odor of sauerkraut, the color of brown sugar, and the odor and color of dark vinegar can be removed from solution by the same procedure as that used for the iodine.

In industry, thousands of tons of adsorbents are required each year for important manufacturing processes. In our modern life, we could do without them only with the greatest difficulty.

So remember this word that looks like another but means something different.

QUESTION BEE

Can You Identify These Pieces of Laboratory Equipment?



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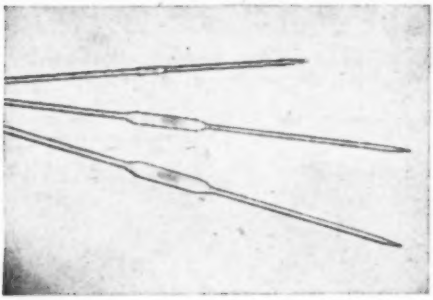

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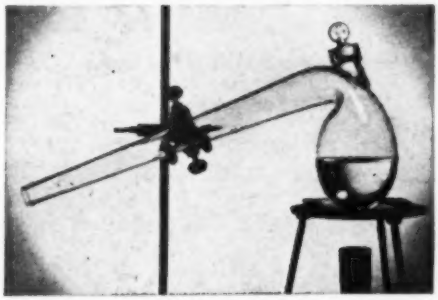


5.....

6.....

ANYONE familiar with a chemistry lab will have no difficulty in identifying the equipment shown here. Write the names in the spaces provided; then turn the page upside down and compare your answers with the correct ones given below.

ANSWERS

1. Pipestem triangle for supporting a crucible over a flame.
2. Iron and porcelain crucibles.
3. Pinchcock.
4. Pipettes.
5. Retort.
6. Drying tube.
7. Wash bottle.

7.....

One-Car Garage Is Spread Apart to Accommodate Second Car

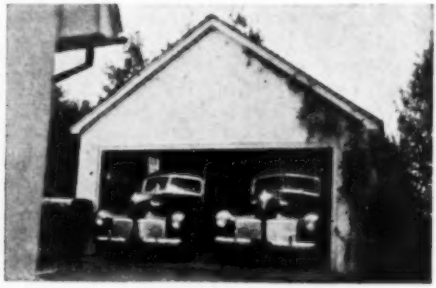
Most home owners with one-car garages worry along and just wish they had room for a second car when overnight and week-end guests arrive. Ira Vail, of Port Washington, L. I., did something about it. He split his narrow garage in two, shoved the two sides apart to required width, and filled in the center portion. How he did it and the result—with the two cars there—are shown in the photos below. The job is one that should be tackled only by carpenters or others experienced in construction work.

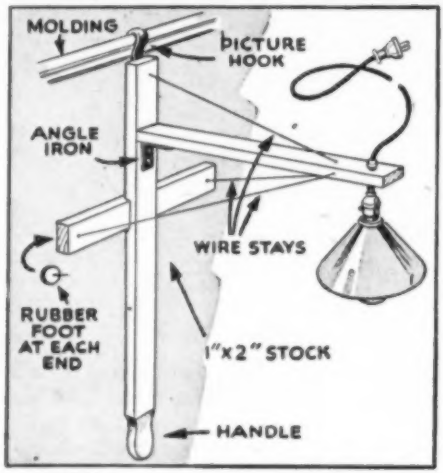
1 Here the stucco finish is first broken away on the centerline to expose the wood for sawing.

2 Then both sides are propped up, the ridgeplate is taken out, and half of the garage is moved.

3 A long beam is put across the double door, the rafters extended, and the ridgeplate replaced.

4 Open parts of the frame and roof are filled in finally, and shingles and finish are completed.

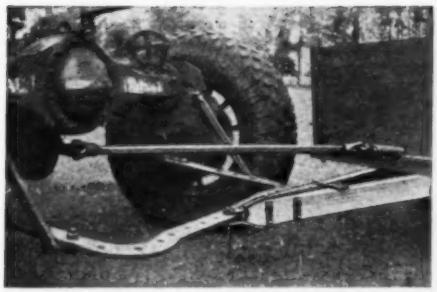


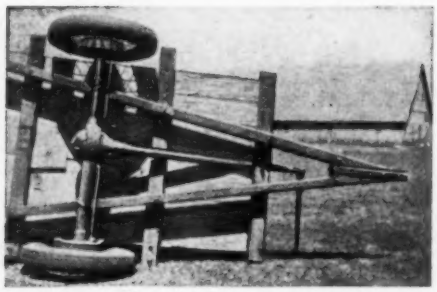


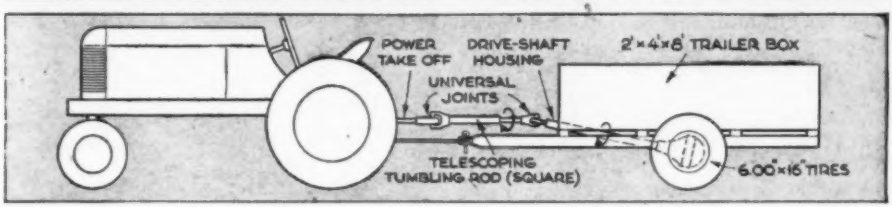
Portable Workshop Lamp Hangs from Molding Along Wall

This lamp is especially useful in the shop because it can be quickly moved to any spot where light is needed and hung on the wall molding. Its portability is limited only by the length of cord and the location of electric outlets.

Attach an arm to an upright piece, securing it with an angle brace, and screw a picture hook to the top for hanging on the molding. A crosspiece lap-jointed on the vertical will keep the arm from swinging, while a handle turned or carved at the lower end provides a grip for moving the lamp. Wires from the vertical piece and crosspiece stiffen the arm.—Otto Woolley.





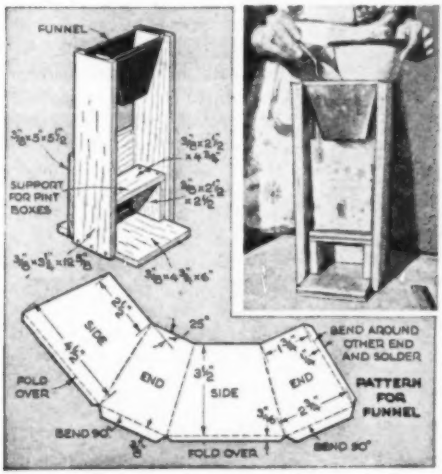


"Shove Buggy" Pushes Old-Model Tractors to Higher Road Speeds

EVEN a tractor can be "souped up." Older farm machines, formerly limited to a road speed of five or six m.p.h., are now cruising highways at 12 to 15 m.p.h.—pushed by powered trailers. The trailer, with a passenger car rear axle driven through the power takeoff of the tractor, does the work while the tractor coasts in neutral. Good roadability is reported.

Originated by South Dakota wheat farmers envious of neighbors' late-model tractors, which have special gears for road speeds up to 20 m.p.h., the "shove buggy" requires few new parts. The drive shaft is removed from the passenger-car rear end and the spline cut off. Then enough smooth shafting is welded on so that the modified drive shaft projects beyond its housing about 2". A straight roller bearing is inserted between the shaft and housing, and a grease fitting installed for lubrication.

Heavy U-bolts fasten the axle to a standard farm trailer. The drive shaft housing tilts up slightly, emerging above the front crosspiece through a notch in the front gate. A telescoping shaft equipped with universal joints connects the drive shaft to the power takeoff.—JOHN N. OLSON.



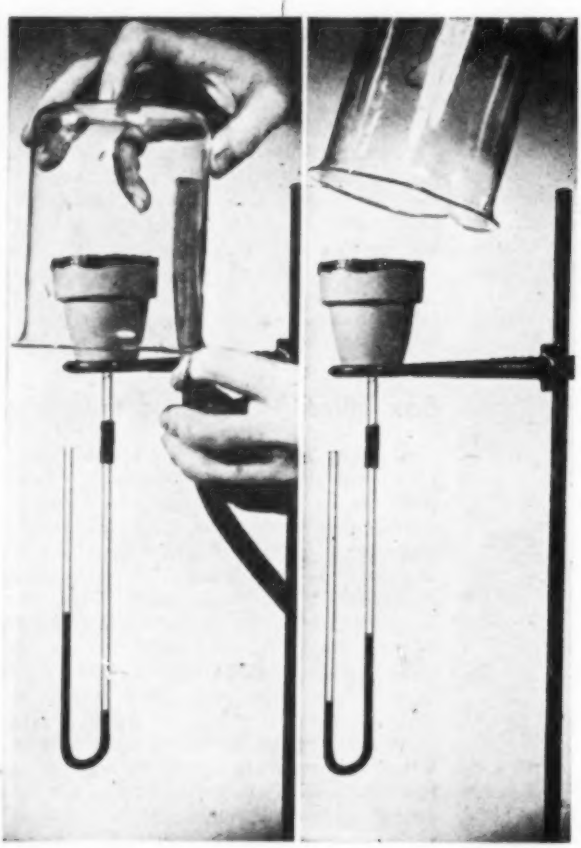
Box Filler Aids Home Freezing

ALREADY one of the simplest of home preserving methods, deep-freezing operations can be speeded up still more with a combination holder-filler that packs cellophane-lined quart and pint freezer cartons at production-line efficiency. For the holder illustrated, which was scaled to fit the available boxes, ⅜" stock was used, although ¼" plywood might be substituted for the sides. The removable platform, shown here in use, raises pint boxes high enough so that no food is spilled in packing. The sheet-metal funnel was cut from a tin can, following the pattern at left. Its edges were rolled over as a safety precaution, and the funnel soldered together. It is nailed in place by two edges.—RALPH S. WILKES.

HOME EXPERIMENTS

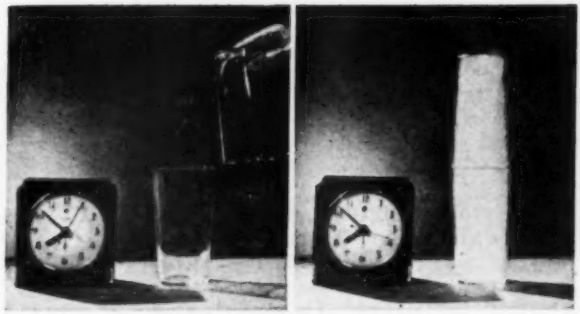
Roving Molecules Create Diffusion

SOME SOLIDS are easily distinguishable by their odor, indicating that these substances diffuse molecules into the air. Naphthalene, of which moth balls are made, is such a material. Place a moth ball and a bit of butter in a jar, as at right, cap the jar tightly, and leave for several hours. The butter will then itself carry the odor of naphthalene. Leave the ball in the open long enough and it will eventually disappear without a trace.



GAS MOLECULES, always in rapid motion, diffuse even through porous solids, the rate of diffusion varying inversely with the square root of the gas density. In other words, light gases diffuse faster than heavier ones. You can demonstrate this with the equipment at the left—an unglazed flower pot sealed at the top with a cardboard disk and wax, J-shaped tubing sealed into the bottom hole, and colored water in the tubing to serve as a pressure gauge or manometer. First, cover the pot with an inverted beaker and introduce illuminating gas. Immediately, the water in the long leg of the tube is depressed, indicating the pressure inside the pot is greater than that of the outside air. The reason? The gas diffuses through the porous walls faster than the heavier air inside can get out. Now reverse the diffusion by removing the beaker. Your manometer will show that the pressure inside the pot falls below atmosphere pressure.

WEIGHT isn't the only explanation when heavy gas diffuses downward through a light gas, for in this experiment you can make a heavy gas diffuse *upward* and a light one *downward*. Molecular movement is the answer.

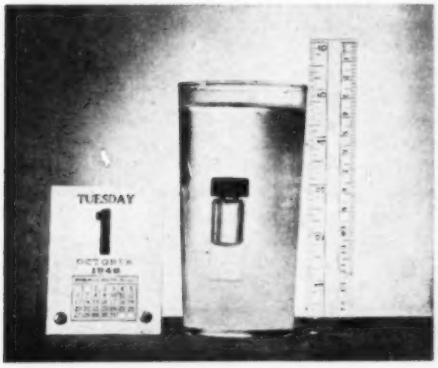


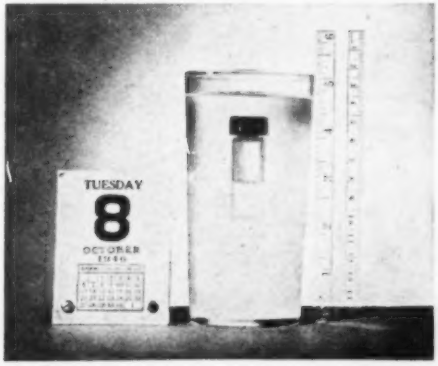
First place a few drops of hydrochloric acid in a tumbler to produce the heavy gas, hydrogen chloride. Then, some distance away, put several drops of household ammonia into another tumbler, swishing it around and finally draining off the excess. These fumes will be the light gas, ammonia.

Now quickly invert the second glass over the first, as above. In only a few seconds, both glasses will fill with a cloud of ammonium chloride particles. These are produced by reaction of the two gases when molecules of the heavy hydrogen chloride move upward and light ammonia molecules go downward.

MOLECULES OF LIQUIDS also are in constant motion. As a result, one liquid will diffuse through another with which it is miscible and through porous solids. Fill a can with dried peas, pour in water to the brim and weight the friction top with an iron. In a few hours, the swelling peas will lift the iron. Why do the peas swell? Because the water, being less dense, enters faster than the solution of solids inside can get out. The result is greater pressure inside than out, and the peas expand.

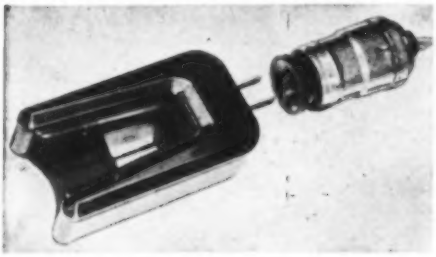
LIQUIDS DIFFUSE more slowly than gases because the movement of liquid molecules is not nearly as great. An experiment to show the slowness of diffusion between a heavy liquid placed below a light one is easily set up. Half fill a glass with plain water, and then introduce a strong solution of salt water underneath by pouring it through a funnel held near the bottom of the glass. Fill a small vial with enough water so it barely sinks in plain water. Thus prepared, the vial will float on top of the salt solution and indicate the line of separation of the two liquids. Cover the glass and place it where it won't be disturbed. A week later the vial still will not have reached the top.





FOR EASIER FARMING

AN ASPHALT POWDER MIX distributed by the Rand-Williams Manufacturing Co., of New York, has many uses around the farm and the home. With an oil solvent added, it can be used for such jobs as repairing leaky water troughs, patching roof leaks, coating roofs, waterproofing fence posts, waterproofing cellar walls, as a caulking compound, and as a fireproof coating on furnaces and pipes. Known as Mixtite, the product also is supplied in the form of a red or aluminum-colored paint.



ELECTROCUTION is one of the newer ways to get rid of mice. An electric mouse trap made by Ratchford Engineered Products, of Dayton, Ohio, operates on regular house current. Two side electrodes and two base pads kill the mouse, and reflex action is then said to throw the body clear.

THIS AX GUARD will prevent injury and keep the blade from being dulled. It is made of heavy leather cut as indicated. Draw the ends and sides together with copper rivets, and cut and attach a belt or strap as shown.—R. A. J.

PORTABLE POWER for a variety of jobs is provided by the Aspen Drive-All, a transmission unit operating from the rear wheel of a car. The basic unit, consisting of ramp, rollers, and main power-shaft housing, weighs approximately 65 lb., and is small enough to carry in the average automobile trunk compartment. Four interchangeable adapters are available for use with the unit. A pulley adapter comes with each Drive-All and is suitable for operating a saw, pump, spray outfit, or blower. Other accessories are a generator to power hand tools and supply emergency power, a centrifugal pump, and a tool grinder. Aspegren Manufacturing Co., of New York, makes it.

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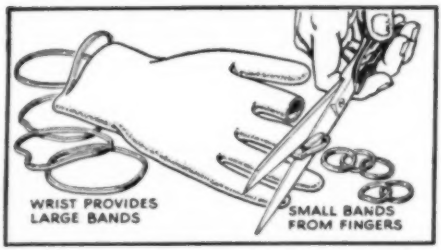


Elastics Cut from Rubber Gloves

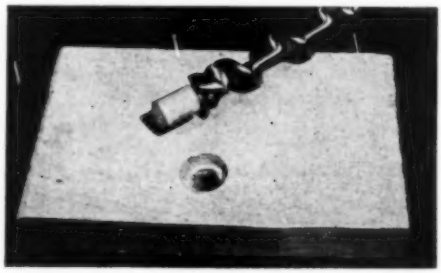
RINGS sliced from the fingers, wrists, and palms of rubber gloves that have been snagged and are no longer leakproof provide a supply of 50 to 100 rubber bands of good grade. Bands may be cut with scissors to any desired width.—R. N. BUCKMASTER.

Bit Ground for Hand-Drill Use

WHEN a square-shank bit intended for use in a brace is needed also in a hand drill, a portion of the shank can be ground round to enter the chuck. A ⅜" length at the end ground to a diameter of about 7/32" is satisfactory, and enough of the square head is left for use also in the brace when there is need.—G. W. E.

Dowel Guides Counterboring Bit

A USEFUL guide for reboring or counterboring holes can be made from a hardwood dowel of the same diameter as the original hole. Cut about a ½" length of the dowel square at the ends, and drill in one end a hole ¼" deep and half the maximum diameter of the end screw on the bit. Turn the dowel on the screw by hand and insert it in the original hole. Several of different diameters can be kept on hand—W. T.



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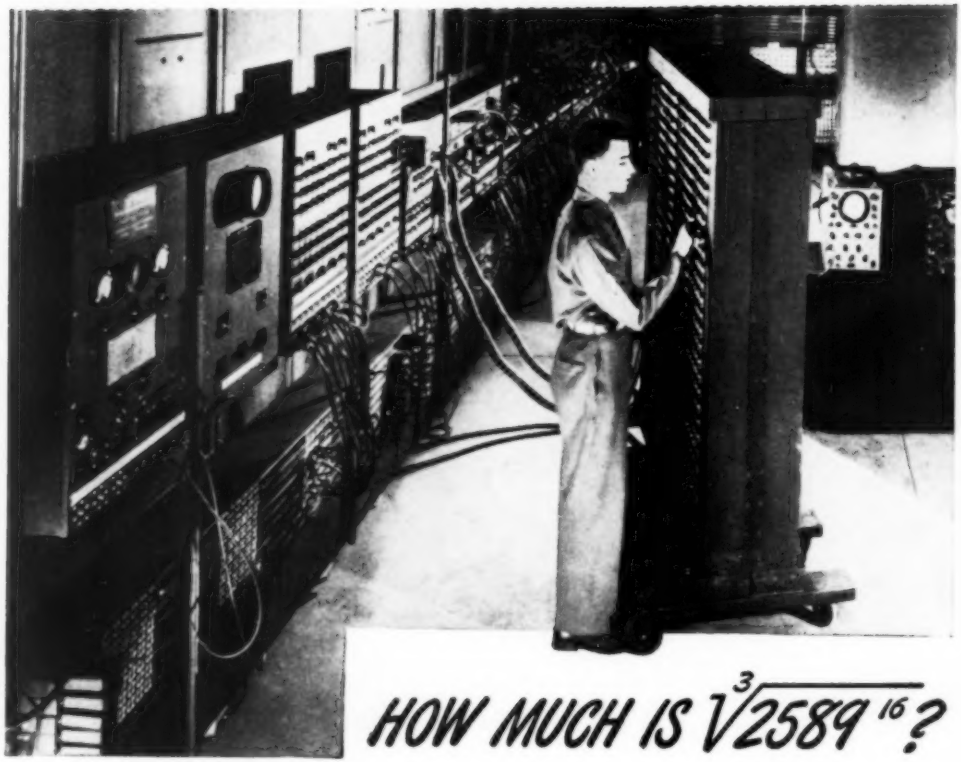

HOW MUCH IS $\sqrt[3]{2589^{16}}$?

The Army's ENIAC can give you the answer in a fraction of a second!

Think that's a stumper? You should see *some* of the ENIAC's problems! Brain twisters that if put to paper would run off this page and feet beyond . . . addition, subtraction, multiplication, division—square root, cube root, any root. Solved by an incredibly complex system of circuits operating 18,000 electronic tubes and tipping the scales at 30 tons!

The ENIAC is symbolic of many amazing Army devices with a brilliant future for you! The new Regular Army needs men with aptitude for scientific work, and as one of the first trained in the post-war era, you stand to get in on the ground floor of important jobs which have never before existed. You'll find that an Army career pays off.

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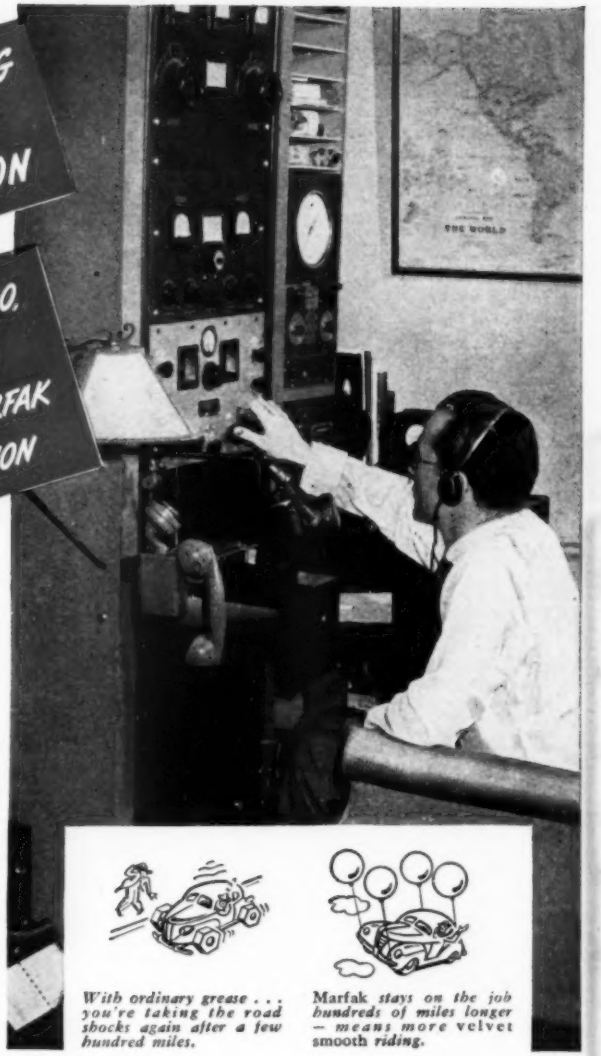
IT'S A GRAND FEELING TO LOG A NEW HAM STATION

IT'S A GRAND FEELING, TOO, WHEN YOUR CAR IS CUSHIONED WITH MARFAK CHASSIS LUBRICATION



HAM radio is fun, talking to other amateurs all over the world. A smooth riding car is lots of fun, too.

With *Marfak* chassis lubrication your car has that "cushiony" feeling . . . not for a few hundred miles, but at least a thousand.

The reason is that *Marfak* is scientifically designed for the job — its special cohesive and adhesive qualities resist wash-out, jar-out and squeeze-out.

Marfak clings to bearing surfaces — sealing out dirt and grime.

Yes, it's a grand feeling when your car is "cushioned" with *Marfak* chassis lubricant. See your Texaco Man today, and say: "*Marfak*, please!"

With ordinary grease . . . you're taking the road shocks again after a few hundred miles.

Marfak *stays on the job hundreds of miles longer — means more* velvet smooth *riding.*

TEXACO DEALERS

SKY CHIEF GASOLINE

FIRE-CHIEF GASOLINE

HAVOLINE AND TEXACO MOTOR OILS

MARFAK LUBRICATION

THE TEXAS COMPANY

Tune in . . . TEXACO STAR THEATRE presents the new Eddie Bracken show every Sunday night. See newspapers for time and station.

TURN GAS AND OIL LOSSES TO SAVINGS WITH BURD "GRAF-FLOX" PISTON RINGS

• Oil-burning, gas-gulping engines take a new lease on life . . . are restored to new-car pep and economy . . . when they get a re-ring job with Burd "Graf-Flox" Piston Rings. You'll be amazed at the improved performance, gratified when you check the savings in gas and oil. There are three principle reasons for Burd's superiority: (1) the use of electric furnace iron for castings, for strength and uniform tension; (2) precision grinding and finishing; (3) Burd's exclusive process for applying deeply penetrating colloidal graphite to the finished piston rings . . . producing rings that seat quicker, wear longer. When your car, truck or tractor acts sluggish, smokes, gives poor gas mileage, it's time to re-ring with Burd "Graf-Flox" Piston Rings. For two FREE booklets described below, mail coupon today.

Burd Piston Ring Co. • Dept. PS • Rockford, Ill.

THIS COUPON BRINGS FREE BOOKS

BURD PISTON RING CO., DEPT. PS,
Rockford, Illinois

Gentlemen:

I'd like a FREE copy of your "Handy Handbook" which tells how to keep my car in good working order. Also send a "Car Economy Record Book."

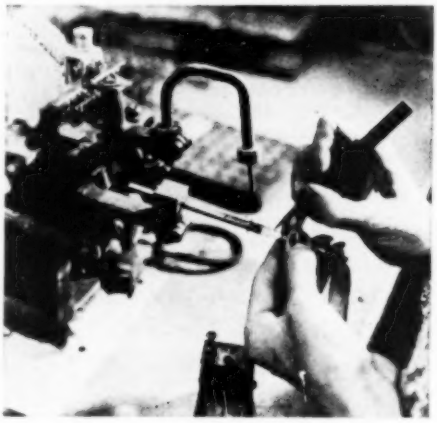
Name. .....

Address..... .....

City.....State.....

Guard Against Skin Diseases

FLEXIBLE, lightweight, transparent garments, fashioned of compar, a limestone-coal-and-air derivative that is impervious to oils and solvents, are protecting industrial workers and helping to stamp out dermatitis. Developed during the war by the Resistoflex Corp., of Belleville, N. J., the material is highly resistant to abrasion and tearing and is made into caps, smocks, aprons (above), gloves and sleeve guards.



Delicate Welding Operation

DEFT, steady fingers are needed to spot-weld tantalum grid wires (.007" diameter) to this tantalum sleeve used in a VT90 transmitting tube, a product of the Amperex Electronic Corp., of Brooklyn, N. Y.

Get the same safe lighting that leading new cars have

LET SAFETY SHARE THE RIDE—
REPLACE WITH GUIDE

Here's one new-car advantage that *every* car owner can enjoy—the safety, efficiency and long life of Guide Sealed Beam headlamp units. Guide units are original equipment on Chevrolet, Pontiac, Oldsmobile, Buick, Cadillac . . . and on more trucks and buses than any other make of lamp. They are right for replacement on *all* cars and vehicles with Sealed Beam headlamps. When you need a new unit, replace with Guide—and get Guide's *double protection* at no extra cost.

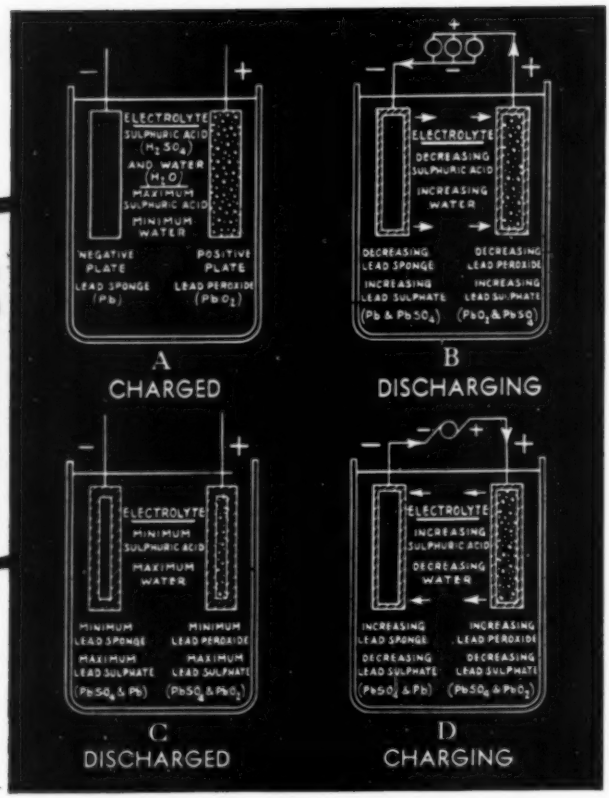
NO DIM-OUT—Because your Guide Sealed Beam unit is sealed against dirt, dust and traffic film, it stays bright throughout its long life—maintains high efficiency without service or maintenance.

NO BLACK-OUT—Because there is a separate bulb within the sealed unit, your Guide Sealed Beam unit will not fail in case of a cracked lens—will light the way safely until the damaged unit can be replaced.

GUIDE LAMP DIVISION OF GENERAL MOTORS CORPORATION

SAFE HEADLAMPS ARE "CORRECTLY AIMED" HEADLAMPS—HAVE YOURS CHECKED TODAY

WHAT GOES ON INSIDE A BATTERY?



The pictures tell the story. When a cell (A) is fully charged, the negative plate is lead sponge (Pb), the positive plate is lead peroxide (PbO_2), and the specific gravity of the electrolyte (sulphuric acid, H_2SO_4, and water, H_2O) is at its maximum.

When discharging (B), the H_2SO_4 is divided into H_2 and SO_4.

The H_2 passes to the positive plate, liberates some of the Pb and combines with the plate's oxygen to form H_2O, thus increasing the water content of the electrolyte.

The SO_4 combines with the liberated Pb and forms lead sulphate, $PbSO_4$, on both plates, reducing acid content and specific gravity of the electrolyte. When sp. gr. reaches 1.150 the battery is discharged (C).

When recharging (D), the current flow and chemical changes are reversed and the plates and electrolyte returned to their original condition.

Because of lower capacities, some batteries discharge more rapidly than others. Exide Batteries are noted for their high capacity, long-life, low cost per mile of operation and strong starting power.

"WHEN IT'S AN *EXIDE* YOU START"

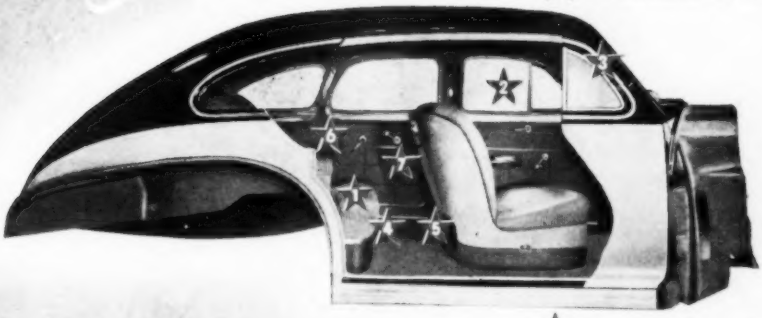
Would you like to know more about batteries? The complete story is told in a booklet, "THE STORAGE BATTERY, Its Fundamentals, Use and Maintenance." Mail a postal card today for a FREE copy.

Exide
BATTERIES

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia 32
Exide Batteries of Canada, Limited, Toronto

BETTER BY FAR

in Comfort



1. Luxuriously upholstered seats with heavy layers of soft yet sturdy padding; strong, coiled springs, supported below by a rugged steel framework. Front seat easily adjustable.
2. Famous Fisher No-Draft Ventilation, individually controlled.
3. Scientifically Planned Vision affords all passengers an unobstructed view. Wide, V-type windshield gives the driver full command of the road.
4. Six different insulation materials combine to completely cover top, bottom and all sides — providing warmth in winter, coolness in summer and quietness all year round.
5. Footrest is recessed into back of adjustable front seat, thus providing maximum legroom.
6. Pull-to armrests are padded with sponge rubber, leather-surfaced on top, and decoratively trimmed.
7. Smartly designed appointments by Ternstedt* include: assist strap holder, interior door handles, window regulators and rear compartment ash tray.

*Fisher Body–Ternstedt Division

If comfort rates high on your list of automobile requirements, decide now to look at a car with Body by Fisher.

Here you will find all the roominess, convenience and built-in comfort developed by Fisher Body craftsmen during 38 years of fine coachcraft.

Such superior comfort gives added value to the unexcelled beauty, sturdy construction and the many extra safety features of the 1946 Body by Fisher.

Body by Fisher

BETTER BY FAR

Thousands of dollars in university scholarships and cash awards for best miniature Napoleonic coaches or model cars submitted by boys of 12-19 years inclusive. For information, write: Fisher Body Craftsman's Guild, General Motors Bldg., Detroit 2, Michigan.

On the Air: HENRY J. TAYLOR, coast to coast, twice weekly. See your local newspaper for time and station.

You get Body by Fisher *only* on

GENERAL MOTORS CARS

CHEVROLET • PONTIAC
OLDSMOBILE • BUICK
CADILLAC

The new 1946 Oldsmobile, 78 Series, 4-door Sedan

For Cabinet Finishing *use* PLASTIC WOOD

in your **HOME WORKSHOP!**

If you'd like a satiny smooth, professional finish on your next cabinet job—use Plastic Wood! It's an ideal filler for cracks or rough grains, dries tight and hard, sands to a swell finish and takes paint, lacquer or varnish perfectly. Here's an extra hint—knot holes or gouges just disappear when this handiest filler is used! *Handles like putty—hardens into wood!*

. . . dozens of other uses

FOR FILLING . . .	FOR REPAIRING . . .
• Countersunk screws	• Loose casters
• Chipped furniture	• Broken balusters
• Nail and screw holes	• Broken furniture

• *You'll want* Plastic Wood SOLVENT, *too.* Get both at one time. It is made especially to control the consistency of Plastic Wood . . . useful also in removing dried Plastic Wood from tools and fingers.

T. M. Reg. U. S. Pat. Off.

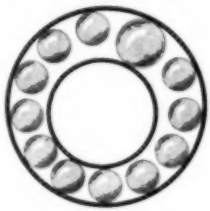
At all Hardware, Paint and 10c Stores

PLASTIC WOOD

Tube or Can

A CELLULOSE FIBRE FILLER

Precision Ball-Bearing Grader



ACCURATE to within 2/100,000 inch, a ball-bearing grader designed by Bell & Howell insures maximum uniformity of bearings in motion-picture projectors. Grading rings like the one at left guide the bearings to numbered chutes; tubes carry them to glass vials.

Magnetic Drill Extractor

CAPABLE of lifting 25 times its own weight, a new drill extractor is used to take broken rods or bits out of holes in rock, often averting a redrilling job. A product of the Dings Magnetic Separator Co., of Milwaukee, the extractor is made of Alnico magnet steel.

Actual Size V-Plug

Model Builders *Attention!*

	V	V-2	V-3
Hex	1/2"	3/8"	5/16"
Thread	3/8"-24	1/4"-32	1/4"-32
Thread Length	7/32	7/32	5/32
Weight, Grams	8	3½	2½

Champion spark plugs for model gas engines give the same dependable performance as regular Champions. Sillment sealed. Sillimanite insulator. Alloy needlepoint electrodes for easy starting. One piece construction.

CHAMPION

SPARK PLUG COMPANY • TOLEDO 1, OHIO

REPUBLIC SEABEE

FAIRCHILD F24R

JOHNSON ROCKET 185

GRUMMAN WIDGEON

CULVER MODEL "V"

AERONCA CHAMPION

BEECHCRAFT D18S

CESSNA 140

ERCOUPE 415C

GLOBE SWIFT

WACO MODEL E

STINSON VOYAGER 150

BELLANCA CRUISAIR SENIOR

NORTH AMERICAN NAVION

HOCKADAY COMET

LUSCOMBE SILVAIRE

TAYLORCRAFT BC12D

PIPER CUB SPECIAL

Here's why most Personal Planes are equipped with

CHAMPION

Spark Plugs

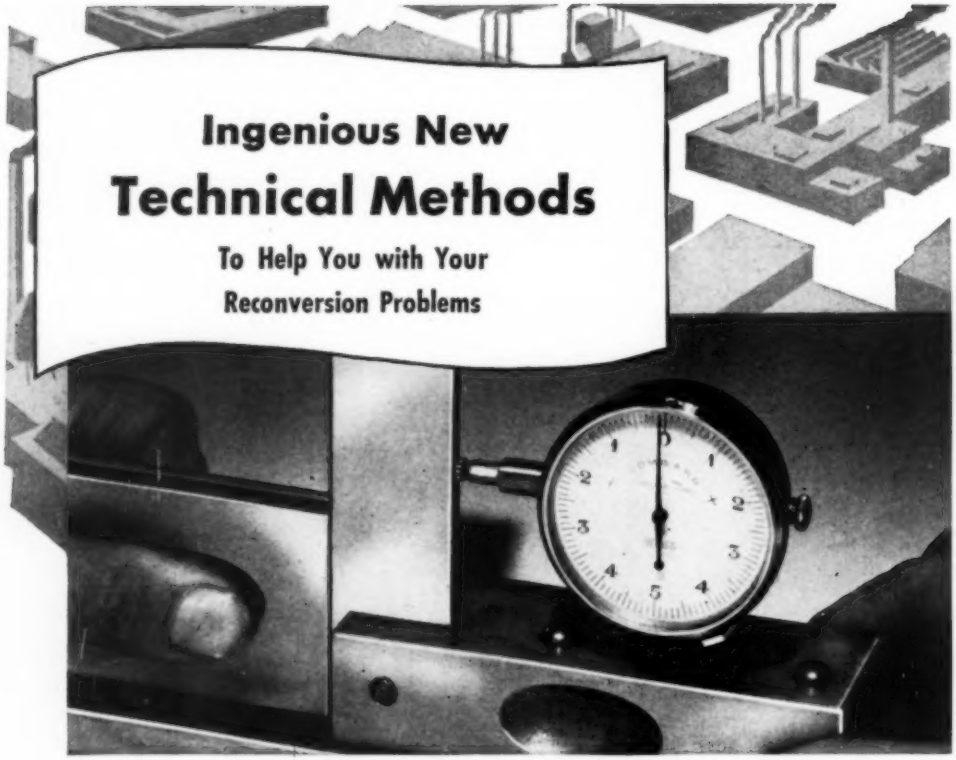
In personal planes the ultimate in dependable engine performance is a "must." Champion Spark Plugs are specified as standard equipment on the overwhelming majority of these engines and used by most private pilots.

Here once again is dramatic proof that Champions make every engine a better performing, more dependable engine. That's why dependable Champions are preferred in every field—why experts insist on them!

Insure championship performance and dependability in every engine you operate—automotive, aircraft or marine—by insisting on dependable Champion Spark Plugs. Champion Spark Plug Company, Toledo 1, Ohio.

THEY'RE DEPENDABLE!

FOLLOW THE EXPERTS . . . DEMAND DEPENDABLE **CHAMPIONS** FOR YOUR CAR



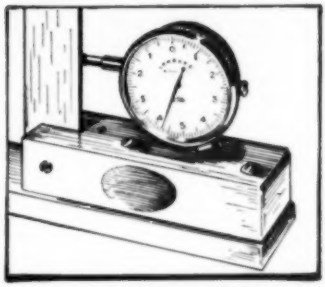
New Micro Square Instantly Checks Right Angles to One 10,000th Inch!

Ideal for precision testing, the Acro Micro-Sine Square quickly and accurately checks right angle work to 1/10,000th inch within a given distance. Its standard indicator dial instantly registers error, location of error, and amount of correction required. Designed for tool and die shops, machine shops and testing laboratories, it also provides a standard for checking master squares, tri-squares and tools.

The Acro Micro-Sine Square is very simple to operate, saves hours of time. Made of hardened tool steel, in ground and lapped precision construction. Available in two types: (1) Standard precision gauge in tenths, (2) Lever indicator in thousandths. Both complete with master checking blocks and carrying cases.

On precision jobs, requiring a static position and mental alertness, workers undergo nervous tension which often results in fatigue. Tests have shown that the act of chewing helps relieve tension—helps workers stay alert, thus increasing their efficiency to do more accurate work. For this reason, many plant owners urge workers to chew Wrigley's Spearmint Gum on this type of job.

You can get complete information from Acro Tool and Die Works
4554 Broadway, Chicago 40, Illinois

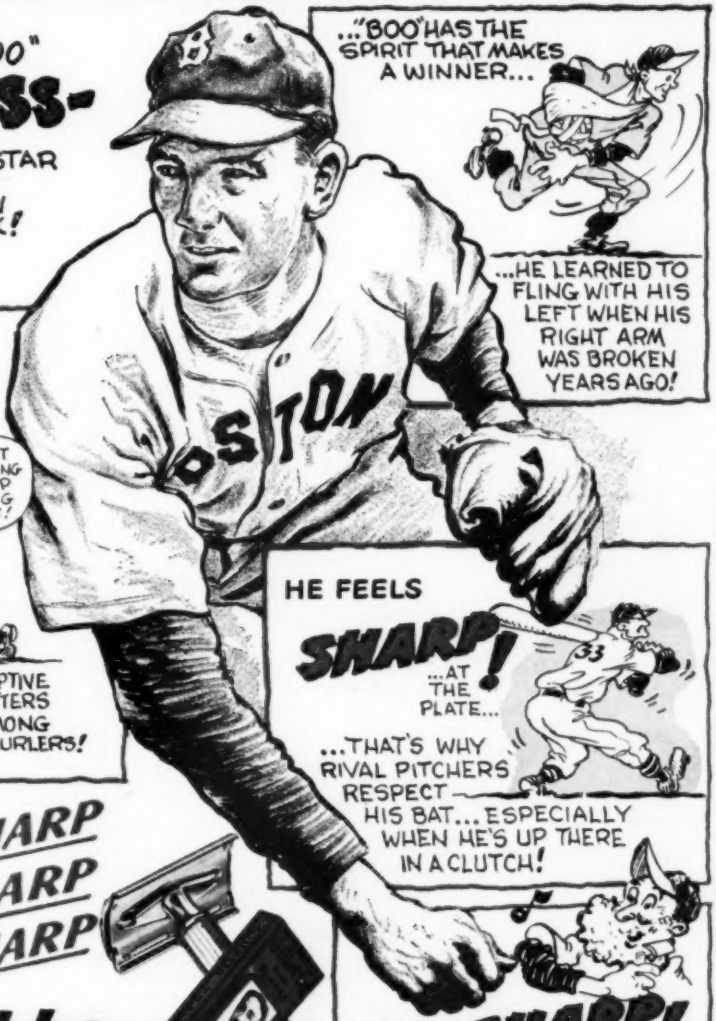


Standard Indicator Dial

AA-92

HE LEARNED THE HARD WAY by FRANK WILLIAMS

DAVE "BOO"
FERRISS-
PITCHING STAR OF THE BOSTON RED SOX!



look SHARP
feel SHARP
be SHARP
use Gillette Blue Blades
with the SHARPEST edges ever honed!

You *look* sharp for you enjoy the swellest shaves ever. You *feel* sharp because they're refreshing and give you a lift. You *are* sharp for you get far more shaves per blade and save money. Ask for Gillette Blue Blades.

5 for 25¢

ENJOY BOXING FRIDAYS AT 10 PM EST OVER ABC NETWORK. GILLETTE'S CAVALCADE OF SPORTS ALSO AIRS WORLD SERIES AND OTHER CLASSICS YEAR 'ROUND

Gillette Safety Razor Company, Boston 6, Mass.

Copyright, 1946, by Gillette Safety Razor Company.

USE AC's FOR
UTMOST
RELIABILITY

Factory-recommended AC's, of correct Heat Range for today's fuels and driving speeds, help millions to be punctual. Have your plugs checked to be sure that you have the right plugs for today's driving and fuels.

Look for this sign

Spark Plugs cleaned and adjusted "By the AC Method" may save as much gas as 1 gallon in 10

SPARK PLUGS

AC SPARK PLUG DIVISION • GENERAL MOTORS CORPORATION

Speeding Up Floor Cleaning

CLEANING, waxing and polishing may be done in one operation with this floor machine, put out by G. H. Tennant Co., Minneapolis, Minn. Accessories are available for scrubbing, sanding and sweeping floors of factories, offices, schools, hospitals, etc. The machine works on wood, asphalt, cork, linoleum and concrete.

Magnets Take on New Shapes

DISPROVING the common belief that magnets have to be hard, General Electric engineers have developed two soft enough to be machined. They are cunico (copper, nickel and cobalt), and cunife (copper, nickel and iron), so ductile they can be shaped into plates, made into screws, punched out in square and circular shapes, and even drawn out into wire.

During the war, cunico was used on tachometers, on small timing motors and in gyroscopes. Cunife was used as a meter magnet to indicate whether airplane wing flaps and landing gear were up or down. Wide peacetime uses are forecast for them.

TO THE MILLIONS OF MEN WHO THINK THEY CAN'T TAKE A PIPE...

Why be a Pipe Exile?

Royalton

Smoke-Control

Assures Pipe Comfort through a great New Invention

In SUPREME GRADE, Imported Briar $2.50. Also in DELUXE GRADE $1.50. Slightly higher in Canada and other countries.

The one *big* reason so many men give up pipes is that the smoke-volume in a standard pipe is too heavy—they can't "take it" . . . Royalton craftsmen set out to build a pipe that *any* man could smoke—that would allow the smoker to cut down or increase the draft to suit his personal preference . . . That pipe is here now . . . The Smoke-Control feature is a simple adjustable valve which widens or narrows the opening through which smoke flows. You can set this valve so that you draw in the *exact amount of smoke* for your taste and throat. Ask your dealer to demonstrate Royalton Smoke-Control.

Write for Interesting FREE Booklet . . . Henry, Leonard & Thomas, Inc., Dept. PS, Ozone Park 17, N. Y.

MOTORCYCLING — "the world's greatest sport" — is now at a new peak of popularity. In every section of the country—more motorcycle fans want Harley-Davidsons than ever before. Even with our production at an all-time high—dealers are selling Harley-Davidsons faster than we can produce them. That's why it's *important* to see your dealer EARLY — if you want the excitement, fun and thrills that go with owning a Harley-Davidson Motorcycle. Because the newest models have *everything you've always wanted* in streamlined beauty together with power, speed, and stamina — they're well worth waiting for until your dealer can make delivery of *your* Harley-Davidson!

HARLEY-DAVIDSON *Motorcycles*

HARLEY-DAVIDSON MOTOR COMPANY, Dept. PS, Milwaukee 1, Wis.
Please send at once free copy of 24-page "Enthusiast" Magazine, filled with motorcycle action pictures and thrilling stories.

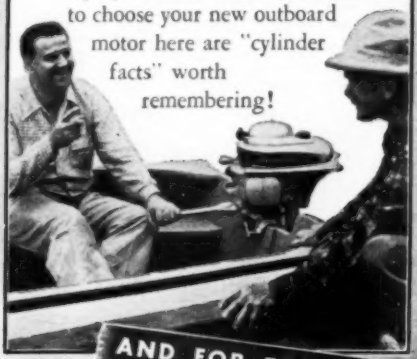
Name.....

Address.....

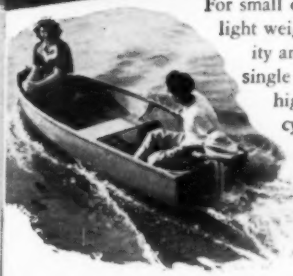
City..... *State*.....

"How many cylinders should an outboard have?"

Of course there is much more to an outboard motor than cylinders and pistons. But the *number* of cylinders does have a lot to do with smoothness, flexibility, power, *performance!* When you come to choose your new outboard motor here are "cylinder facts" worth remembering!



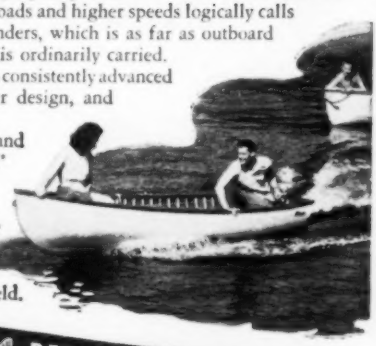
ONE CYLINDER IS FINE . . .



For small outboard motors, where light weight and handy portability are prime considerations; single cylinder construction is highly satisfactory. Single cylinder design has come a long way since Ole Evinrude "started it all" back in 1909, and Evinrude's highly developed "Ranger" and "Sportsman" are favorites with outdoor folks everywhere.

TWO CYLINDERS . . EXCELLENT

The next step up in power for heavier loads and higher speeds logically calls for two cylinders, which is as far as outboard engineering is ordinarily carried. Evinrude has consistently advanced twin cylinder design, and Evinrude's "Sportwin" and "Speeditwin" are today two of the most popular models in the two-cylinder field.



AND FOR TOPS IN THRILLING PERFORMANCE—

CHOOSE A "FOUR"

Tens of thousands of enthusiastic owners will tell you, "For tops in performance and pleasure — own a four". Only Evinrude offers four-cylinder outboards, and Evinrude builds with a background of 18 successful years in perfecting these superbly smooth and spirited motors Four great "fours"* to choose from — two of them smack in the range of two-cylinder power, weight, price!

See your Evinrude dealer — look for his name in your classified phone directory under "Outboard Motors". Complete catalog of 8 Evinrude models sent free . . . address EVINRUDE MOTORS, 5375 N. 27th St., Milwaukee 9, Wis.

In Canada:
Evinrude Motors, Peterboro, Ontario.

EVINRUDE
OUTBOARD MOTORS

**Motor shown is the "Lightfour", 66 lbs., 9.7 O.B.C. certified brake horsepower at 4000 R.P.M.*

Smooth, steady power at your fingertips! Perform precision operations not possible with any other portable tool! With a Handee you can turn out professional looking projects for pleasure or profit—ship, plane and train models, costume jewelry, wood carvings, puppets, initialed tumblers, etc. AC or DC. 25,000 r.p.m. Wt. 12 oz.

USE THE RIGHT ACCESSORIES! Choose them from the most complete line . . . more than 300 made right in the Handee plant.

A GOOD START—THE HANDEE KIT

HANDEE Tool and 45 most popular accessories packed in compact steel carrying case. You'll be amazed at what you can accomplish! Complete, postpaid. **$27.50**

Handee only, with 7 accessories, $20.50

FOR YOURSELF OR A FRIEND . . . THE GIFT OF A LIFETIME!

NEW PRECISION ATTACHMENTS

Fit Handee only, enable novice or craftsman to do perfect work. Magically, easily, your offhand carving, routing, shaping will be exact as to depth of cut, accuracy of line. Set of 6 attachments with instructions, postpaid **$7.95**

ORDER NOW! SATISFACTION GUARANTEED!

FREE! NEW 52-PAGE MANUAL

CHICAGO WHEEL & MFG. CO.
1101 W. Monroe St. Dept. PO, Chicago 7, Ill.

Send ☐ Handee Kit ☐ Handee Tool ☐ Precision Attachments ☐ C.O.D. ☐ Remittance enclosed ☐ Send Manual

Name.....

Address.....

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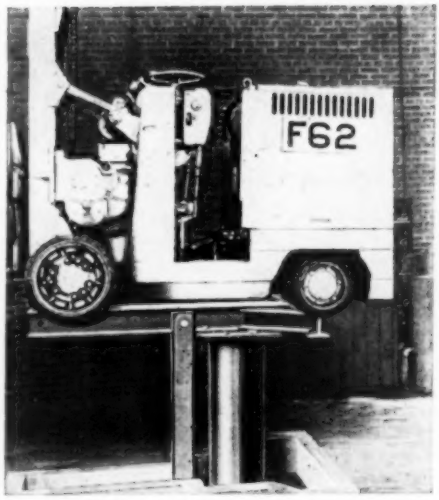
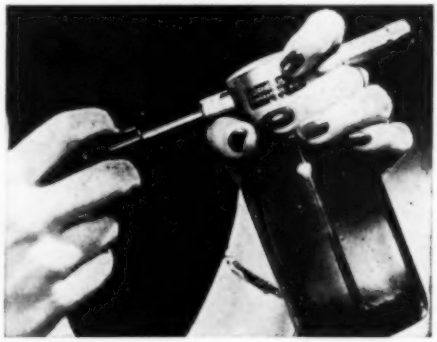


Power-Truck Service Station

A REVOLVATOR hydraulic elevator here is being used for servicing power trucks. Its platform consists of one longitudinal and one transverse H-beam. A sump pit is provided for lowering the ram so that the truck can be driven directly onto the platform. Adjustable axle blocks, fore and aft, hold the elevated truck in position with wheels turning free.



Tiny Sprayer Makes Big Fog

A TINY precision sprayer for insecticides, lotions, antiseptics and deodorants throws billows of mist with a single stroke of its 2½-inch piston. One push develops an average nozzle pressure of 300 pounds. The working parts of the 8-ounce sprayer, which is made by the Cornelius Company, Minneapolis, are of machined brass and stainless steel. It can be held in any position without leaking.

YOU WERE WRONG WHEN YOU BROUGHT HOME A STRAY "TOM" CAT

Motoring troubles multiply, too, when spark plug wires are old and worn. So, if you want peppier, smoother, more economical performance from your car—the *right* thing to do is replace with Packard ignition cable.

The fact is that worn-out spark plug wires may be wasting as much as one gallon of gas out of every ten because of sluggish motor performance. When that new Packard cable takes over the job, you're in for thousands of better driving miles. The name "Packard" is your assurance of the best in cable materials, the best in cable design, the best in cable construction.

But... YOU'RE RIGHT with PACKARD CABLE!

The makers of leading cars, trucks and buses specify Packard ignition cable as original equipment; most leading garages and service stations rely on it for replacement. That's a pretty reliable tip-off that you'll be *right* with Packard cable!

PACKARD CERTIFIED RE-WIRING SERVICE

This sign means cable service at its best—the right Packard cable *and the right methods*. Thousands of dealers provide better electrical service as a result of the Packard Certified Re-Wiring Program.

AUTHORIZED CERTIFIED RE-WIRING SERVICE

Packard

REG. U. S. PAT. OFF. TRADE MARK

PACKARD ELECTRIC DIVISION
GENERAL MOTORS CORPORATION
WARREN, OHIO

FOREMOST BUILDER OF AUTOMOTIVE AND AVIATION WIRING

THE ONLY BRUSH THAT

Keeps the Air Clear as it Cleans the Floor

Also Eliminates Sweeping Compound!

The dust itself is converted into sweeping compound—cannot rise into the air.

Dustless brushes used with Arbitrin sweeping fluid are 100 times more effective in controlling dust than ordinary floor brushes used with sawdust. When used daily, Dustless brushes actually reduce bacteria, normally in the air between sweepings, as much as 97%. These facts have been proved in tests made by independent health authorities. Dustless brushes are used in thousands of stores, factories, offices, schools, and institutions. They are unconditionally guaranteed to meet your requirements. Write today for sizes, styles, and prices.

MILWAUKEE DUSTLESS
BRUSH COMPANY
530 North 22nd Street · Milwaukee 2, Wisconsin

MANUFACTURERS OF DUSTLESS, SPEED SWEEP AND SPEED WASH BRUSHES

106

Milwaukee Dustless Brush Co., 530 N. 22nd St., Milwaukee 2, Wis.
Please send complete information about Dustless brushes and Arbitrin sweeping fluid.
Name.....
Address.....
City and State.....

BUILD THEM YOURSELF!

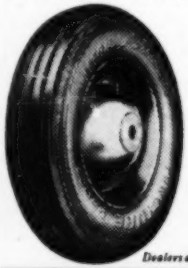
IT'S EASY with *WALTON* DELUXE WHEELS

STEEL HUB • ROLLER BEARINGS
PUNCTURE PROOF RUBBER TIRE

America's finest and fastest wheel, they are better—sturdy steel hub, high speed roller bearings for smoother, faster riding—scientifically balanced—puncture proof rubber tire with deep heavy tread—built-in air cushion to absorb shocks—no tube necessary—fits any 1/2" axle.

THRILLING FUN — PERFECT GIFT
Make Him the Proudest Kid in Town!

Walton Deluxe multi-purpose wheels roll like sixty. Swell for speedy scooters, racers, coasters, mobile lawn furniture, delivery wagons, food carts, wheelbarrows, homecraft or industrial uses. Get started today, order now, immediate delivery.



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COMPLETE
Price includes tire, hub and bearings. Completely assembled, ready to roll. Axles and other parts obtainable locally.

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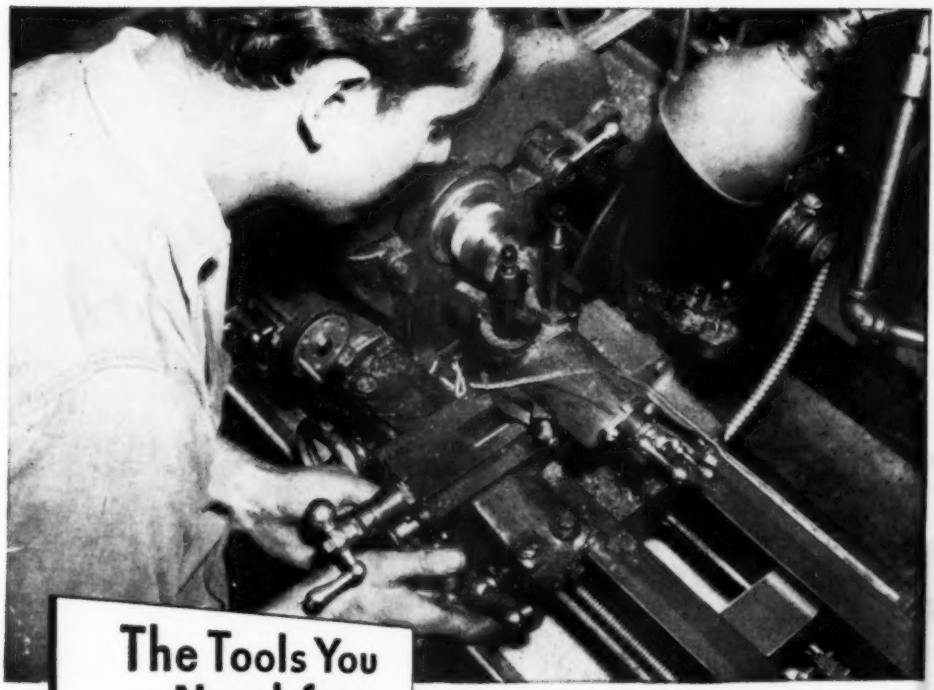

The Tools You Need for YOU, INCORPORATED

Setting up your own shop is usually a one-time investment — for a lifetime of dividends.

Whether you have in mind the highly practical part of such a fascinating hobby — building and repairing home equipment — or will use the shop in your business, you need *precision* tools of *wide versatility*.

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Accuracy in construction and operation, of course, was basic. Then they made sure Atlas tools could handle all the types of machining you might require. Next extra-heavy castings were designed to assure solid machines for smooth operation even under unusual loads. Finally, they devised ingenious production methods, new to the industry, to bring you the tools at lower cost.

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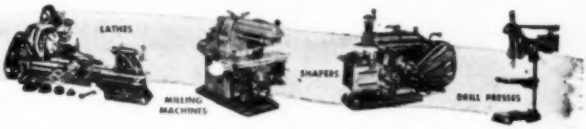
Atlas 4 TOOL TEAM



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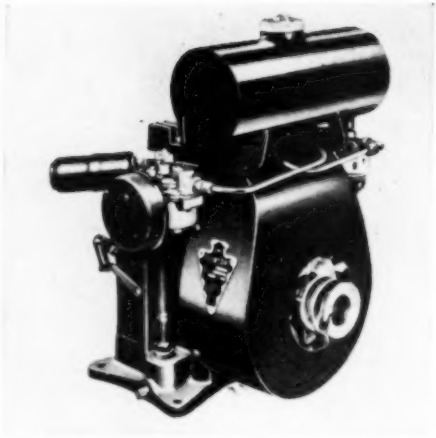

Versatile Small Gas Engine

A NEW 40-pound gasoline engine developing 1-1.5 hp. at 2,000 to 3,600 r.p.m. is being made by the Clinton Machine Co., Clinton, Mich. It is designed to power lawn mowers, scooters, pumps, refrigeration units, and even small boats.

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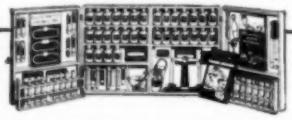

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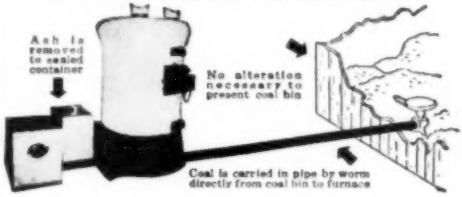

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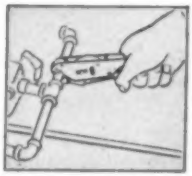
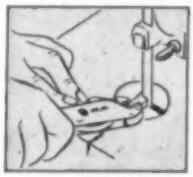


Utility pipe wrench



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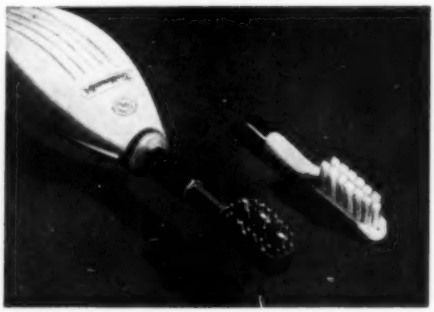

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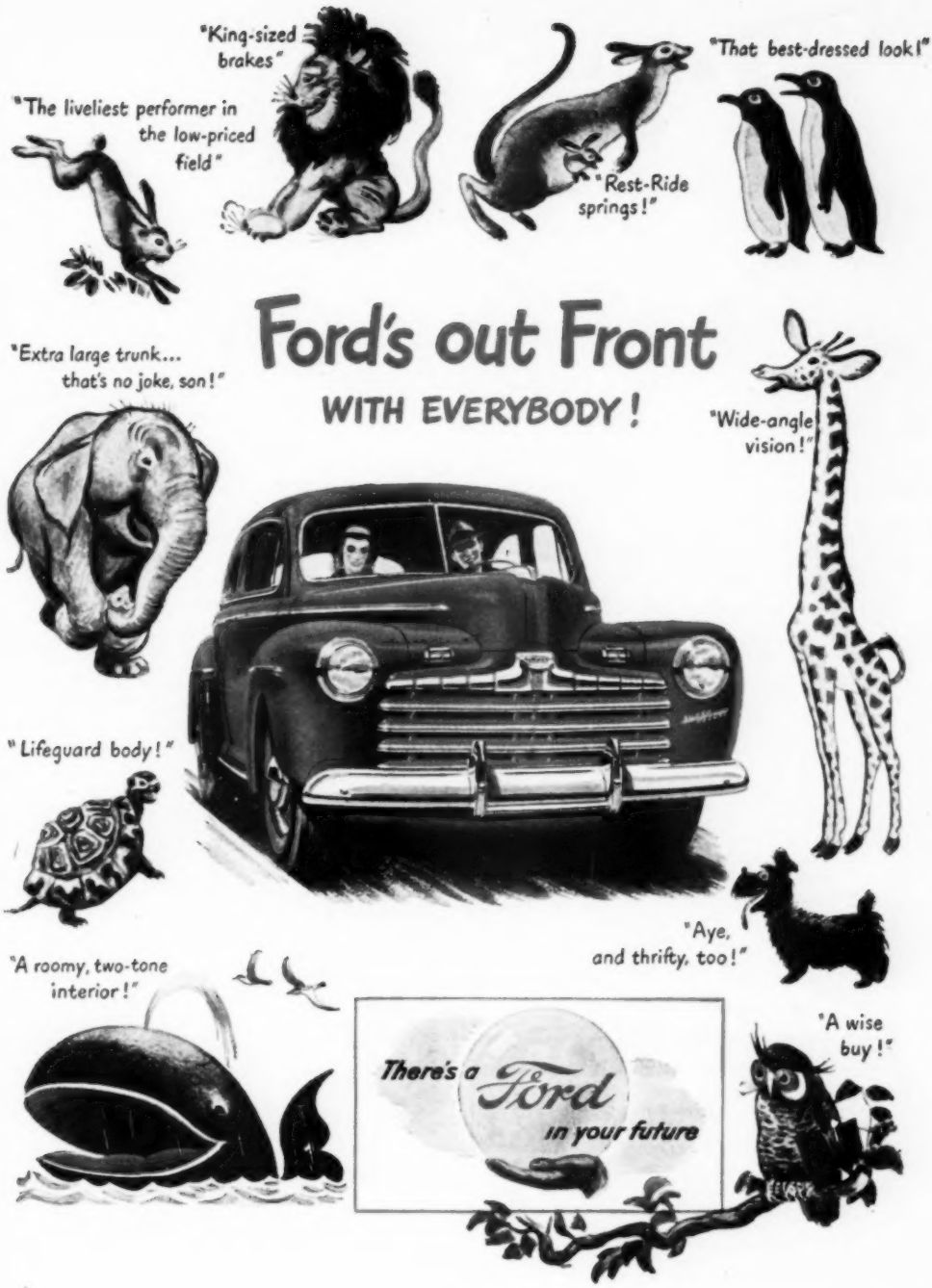
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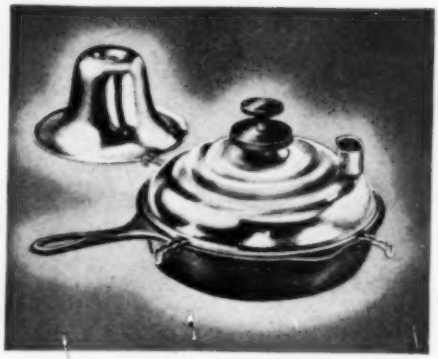

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Your workshop can now have a Logan Lathe

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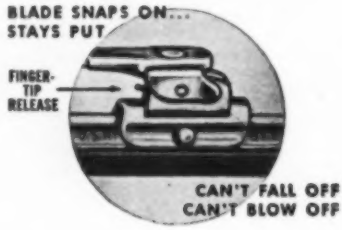

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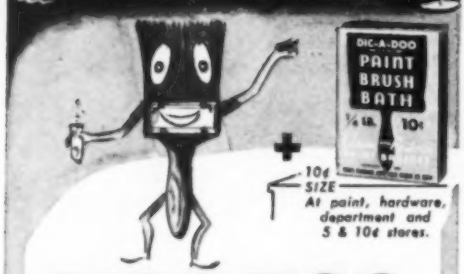

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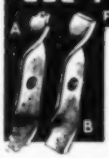

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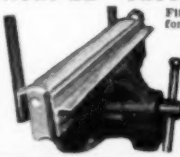
Rt. 1-P, Clearwater, Fla.

New! 12" Sheet Metal Brake Only $12



Fits in bench vise. Quickly, easily forms all kinds of angles in sheet metal, strap iron and aluminum, copper and plastic. Use it to make useful articles, experimental research work, patent models, etc. Simple gages made for quantity duplicating. New cast model now available. Send for details, or order direct. C.O.D. $2.00 deposit. Wt. 10 lbs.

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FREE INFORMATION ON *THREE* BIG NEW MONEY-MAKING OPPORTUNITIES

Send for FREE Details

Regardless of your age, sex, previous experience, and whether you are an ex-serviceman or not, we will send you astonishing free facts about the unlimited possibilities—in your own business—with amazing LIQUID MARBLE and our other marvelous new products. To secure this information, absolutely free, fill in coupon below or send a letter or postcard. No salesman will call on you now or ever. Write TODAY! Offer limited.

1. **LIQUID MARBLE.** Make beautiful artificial Marble Slabs. Pour from liquid state. Glazed or unglazed. This marble may be mottled, veined, multi-colored or left in original snow-white state. The color is actually a part of the marble! Does not fade or wear away. LIQUID MARBLE is unsurpassed on kitchen or bathroom walls. Easy to make and install.
2. **PLASTIC FLOORING.** May be made in any color or combination of colors. Gives a lifetime of wear. Dustproof. Soundproof. Verminproof. Resilient to the tread. Lay out solid from wall to wall or in pattern design of various shaped blocks.
3. **FLEXIBLE MOLDS.** For plaster casting. Make your own molds for few cents each. $1.00 in raw materials will make up to $25.00 worth of finished goods. We furnish names of buyers.

FREE EXTRA! If you write us promptly we will include free information about our other big money-making businesses. These include Compo-Tile Roofing and Caen Stone, Plastic Wood, Artificial Marble and Granite, Stone and Metal Solder, Plastic Tile Cement, Papier Mache, and many others.

Greatest Opportunities NOW!

With reconversion going ahead full speed, NOW is the time to line up your own money-making business. We offer you our **BIG THREE** money-making opportunities together with other equally profitable businesses. (See paragraph at right.) Get the FREE facts TODAY!

COMPO-TEX, Box 786-RV, St. Louis, Mo.

FREE INFORMATION COUPON!

COMPO-TEX, Box 786-RV, St. Louis, Mo.

Please send me free details of your **BIG THREE** Money-Making Propositions including LIQUID MARBLE. Also include information about the additional new business possibilities given directly above.

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ELECTRIC DREMEL POWER TOOLS

OWN A "POCKET SIZE" MACHINE SHOP

IMPROVED MOTO-TOOL

27,000 R.P.M. CUTS CLEANER SAVES CUTTERS

Moto-Tool No. 2, 23 accessories, in wood case, $23.50 (Moto-Tool one accessory $16.50).

• Dremel "Moto-Tools" have been used by toolmakers, machinists, pattern makers, electrical and radio repairmen, home craftsmen, model makers, jewelers, hobbyists, sportsmen and handymen for over 10 years. Moto-Tool is a "war veteran" . . . Thousands of them were used at far flung maintenance bases by every branch of the armed forces. "Moto-Tools" are in use in tool rooms and on production lines at General Electric, Westinghouse, Remington Arms, Ford, Nash-Kelvinator, Consolidated Aircraft, Douglas and others.

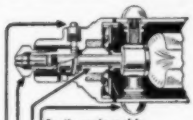
DO THESE JOBS BETTER AND FASTER WITH A "MOTO-TOOL"

Sharpening taps, gouges, chisels, wood drills, lawnmowers, knives, scissors, cutting tools, etc.; for grinding, routing, drilling, cutting, carving, engraving, sanding, polishing, cleaning, etc., in metal, wood, plastics, etc.

MONEY BACK GUARANTEE—Ask your dealer about Dremel "Moto-Tools" and accessories. If he does not handle them, order direct from the factory on a 10 day trial, money back guarantee.

DREMEL MFG. CO., Dept. 126-K, RACINE, WIS.

LOOK FOR THESE MOTO-TOOL FEATURES



Patented, automatic chuck lock pin.

Instant-acting, wrenchless chuck.

Easily replaceable commutator brushes.

Oil-less type, sealed bearings.

Weighs only 13 oz. • Operates on 110-120 AC or DC current • Shockproof bakelite housing fits the hand • Dynamically balanced armature eliminates vibration • Cooled by dust-filtered air • Sliding, snap-type switch • Hang-up hook • Cord protector.

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Racine, Wisconsin

☐ Enclosed find $..... (Money order or draft). Ship the following at once
☐ "Moto-Tool" Kit No. 2 ..... $23.50
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☐ Enclosed find $2.00. Ship above C.O.D. I'll pay postman balance plus postage.
☐ Send catalog of Dremel Tools and Equipment. FREE.

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Keep your heating and plumbing systems, your household equipment, utensils, tools, etc. in repair with handy Smooth-On No. 1 Iron Repair Cement. You can do it yourself—make good-looking repairs that stay tight—yet are very inexpensive.

Smooth-On comes in powder form. You mix it with water to apply. It hardens like metal. Stops leaks. Seals cracks. Tightens loose bolts, screws, rivets, parts, fixtures. Holds in metal, wood or masonry. Requires no heat, and usually no need to take things apart.

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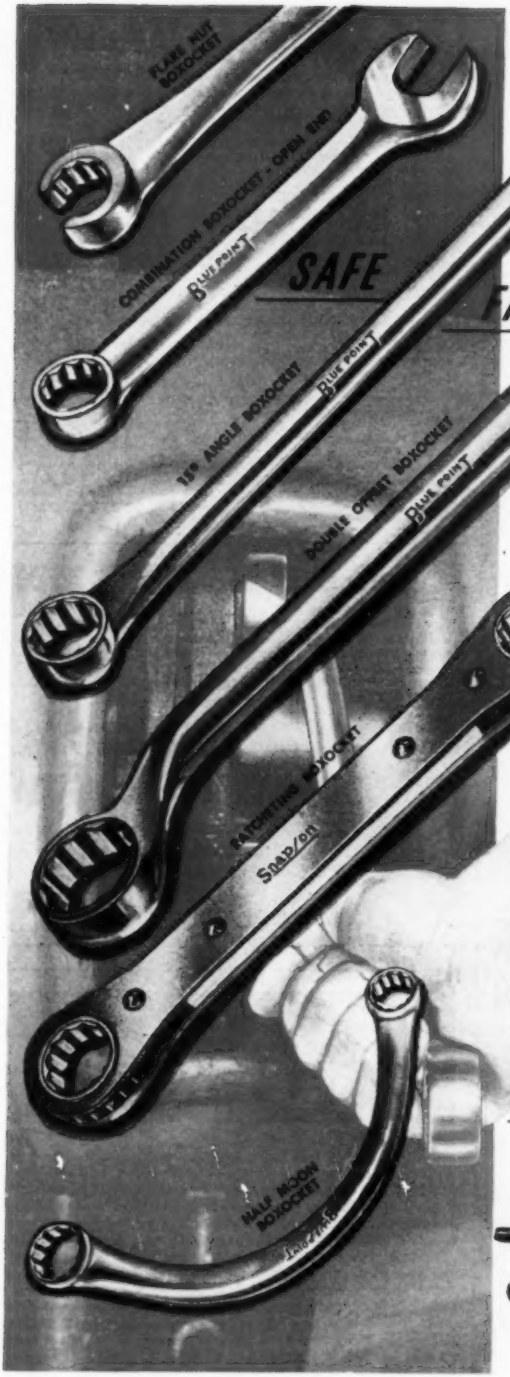
Do it with SMOOTH-ON IRON CEMENT

Plate and Cup Molded as Unit

For meals eaten without benefit of a table, the New Plastic Corp., of Hollywood, Calif., offers a molded plate and cup to lessen the hazards of cup juggling. Notches in the extended lower edge of the cup fit snugly over ridges that divide the plate into three sections, so that the two pieces can be used as a compact unit or separately. The plate and cup are compression-molded of melamine or urea formaldehyde plastic, which has no effect on food or liquids, however hot, that come in contact with it. The plate and cup may be washed in boiling water, but soaking them for a long time in either hot or cold water is not recommended.

Better Artificial Limbs Sought

American inventors and engineers are urged to submit ideas for better artificial limbs to the National Inventors Council, Department of Commerce, Washington, D. C. The chairman of the Committee on Prosthetic Devices, Dr. Paul E. Klopsteg, says better joint mechanisms, lighter materials, improved fabrication, and better fitting methods are needed to care for 17,000 war casualties and an estimated 25,000 civilian amputations annually.



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Powerful, safe leverage that invites confident wrench speed

Slipping handily into hard-to-get-at places . . . engaging the nut on all *six* corners with an encircling can't-slip-can't-spread grip . . . needing only *half the space* of an end wrench for full handle movement . . . Snap-on Boxockets are *speed* tools and *safety* tools on tough nut-turning operations. Chamfered openings slip readily over the nut. Double broaching permits operation within a 15° arc. Round handles provide comfortable grip. Snap-on Boxockets work swiftly and efficiently in many spots inaccessible to other wrenches.

For maximum usefulness on a wide range of work, Snap-on offers 13 types of its popular Blue Point Boxockets — in angled, offset, combination and flare nut heads — and in standard wrench sizes from 3/16" to 4 5/8". Available everywhere through Snap-on's nationwide direct-to-user tool service.

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SMALL EFFICIENT SPEED REDUCER

Sturdy, compact (see dimensions). Proved in thousands of industrial installations. Case of heat-treated aluminum. Gears, SAE 65 (British Gear) Bronze. Worm of case hardened steel. Timken Bearings throughout. Available in 4 different assemblies (shown below) and in these standard ratios:

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16-1	50-1	100-1	600-1
20-1	60-1	150-1	800-1

$15.12
Catalog Price
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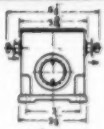
Torque capacity 100 inch pounds. Especially suited for bench work, home work shops, light production, animated displays, etc. When ordering be sure to specify assembly and ratio required. Shipping weight in carton, 8 lbs. Full money back guarantee. **Prompt deliveries.**



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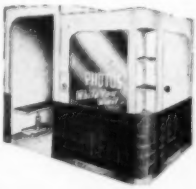

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Only $6.95 Complete with shoulder cord

Now you can take *perfect* pictures ... because you see *exactly* what you'll get on your film *before* you snap the shutter! Yes, you see the ENTIRE IMAGE in sharp, clear focus (as in the costliest cameras) with the **GROUND GLASS VIEW FINDER** of the amazing new double-lens Metro-Flex Camera ... available for the first time since the war at a remarkable low price! With the Metro-Flex Camera you're **sure** of results on all kinds of shots. Close-ups, scenes, people, events ... they all come out just as you see them in the Ground Glass View Finder ... **before** you snap the shutter!

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One lens focuses the picture for you. The other snaps the picture. Both lenses, working in harmony, give you sharp focus never before available except in most expensive cameras. The Metro-Flex is a beautiful camera ... handsomely, sturdily made ... modern-design plastic case ... bright aluminum, rust-proof trimmings ... high speed, optician-ground lens ... time exposure adjustment ... and complete with plastic shoulder cord. Easy to load and use. Will give years and years of picture-taking fun. Takes 8 exposures on standard No. 127 film.

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1 Easy focusing ... you see entire picture before you take it, just as it will look when developed!

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3 Everything you want to take ... no disappointments, because you see the **whole** picture, framed as it will appear on the film.

SPECIAL! *20-Page Photo-Album included with Camera at no extra cost!*

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Order your Metro-Flex Camera now, complete with Ground Glass View Finder, double lenses, and shoulder cord. Send No Money. Just mail coupon at right and pay postman only $6.95 plus postage on delivery—we pay postage if you enclose $6.95. Use Metro-Flex Camera for 10 days, and if you're not delighted, return it, and your money will be instantly refunded. Rush coupon. Supply limited.

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FILM AVAILABLE!

The METRO-FLEX uses any standard make of No. 127 film. Order a supply of film on coupon below when you order camera.

3 Rolls (8 exposures per roll) 96c
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No film sold without camera, on first order but as Metro-Flex owner you may order future supplies of film from us at above prices.

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And grand fun too, with a

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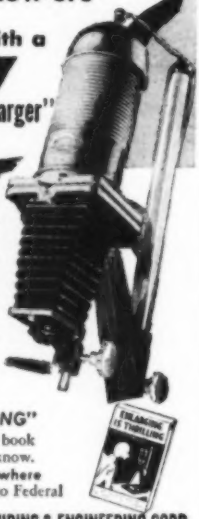

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Model #14 $5
Dozens of others—antique or smooth finish.

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Write for "Pipes—for a World of Pleasure." It's FREE
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Project your motion pictures and slides on a screen which makes them fairly "POP OUT" into the room with you. Thrill to sharper, clearer black-and-white pictures . . . richer, more vivid color shots. Such performance is the result of the Radiant "Hy-Flect" Screen surface . . . thousands of tiny glass beads set in the snow-white plastic screen surface—glass beads that *reflect* light, never absorb it. You get this in New 1947 Radiant Screens . . .

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All pictures look better . . . when projected on the new finer, instantly adjuttable Radiant Screens.

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BETTER SCREENS FOR BETTER PROJECTION

Send for FREE Screen Guide
"Secrets of Good Projection," a 32-page booklet, gives proper screen sizes, correct projection lenses, tips for improving projection and many other valuable facts. Mail coupon for your FREE copy.

The Radiant "DL" here illustrated is portable, sturdy, compact, easily set up, quickly adjustable. The Radiant line includes Wall, Ceiling and Table Models in sizes 22" x 30" to 20 feet by 20 feet and larger.

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Send me FREE copy of "Secrets of Good Projection"—also circular showing complete line of Radiant Portable, Wall, Ceiling and Table Screens.

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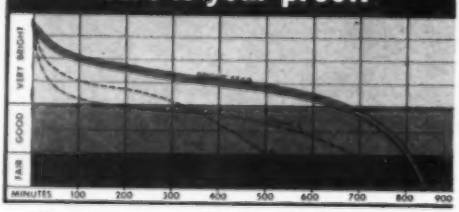
Now! tests prove-

BRIGHT STAR BATTERIES

give more bright light longer

Here is your proof!



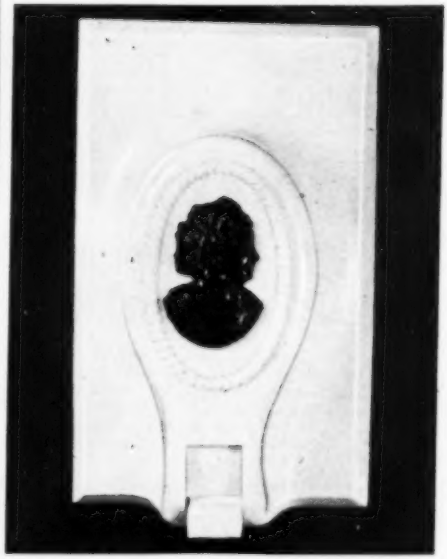
These results of vital service tests* prove that Bright Star batteries give you more *bright light* longer than the two other leading brands tested. Insist on the best —it's Bright Star by test!

**Chart based on laboratory tests conducted under government standards.*

BRIGHT STAR BATTERY COMPANY, CLIFTON, NEW JERSEY

Heating Unit in Cooking Pan

THIS Snak-pan of polished cast aluminum has sealed-in electric heating elements, and is complete in one unit. Construction is rugged, but it is lightweight. Washing in water will not damage it.



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TO BLEND harmoniously with the decoration of any room, an easily cleaned, plastic light-switch cover in standard colors is put out by the R.E.C. Mfg. Corp., Holliston, Mass. No new holes need be drilled and it is easy to fasten it over the regular switch with a screwdriver. A cameo-like ornament decorates the cover.

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Wrist Compass and Strap

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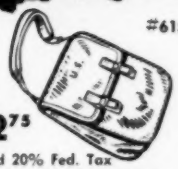
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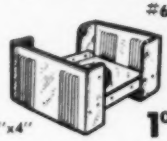
Add 20% Fed. Tax
Canvas Musette Bag

#639

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#687 — Khaki 2¼" web, non-rust hardware. Adjust to 42". (White belts $1.95.) **1.75**

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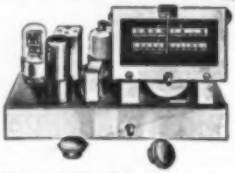

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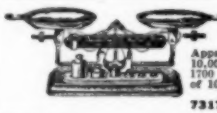

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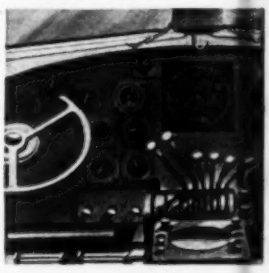

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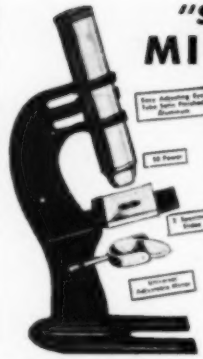

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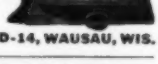

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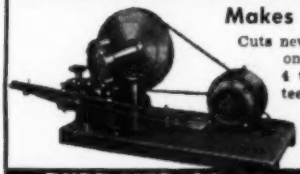

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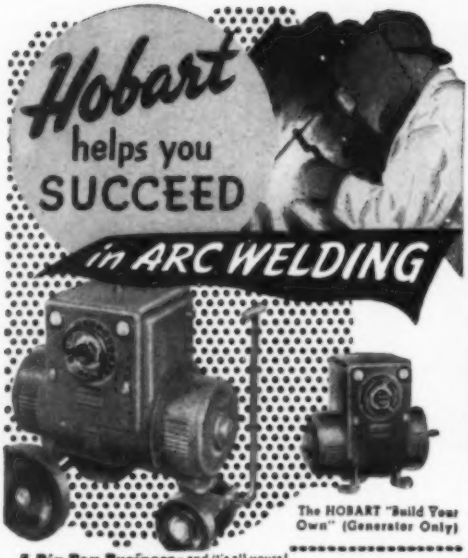

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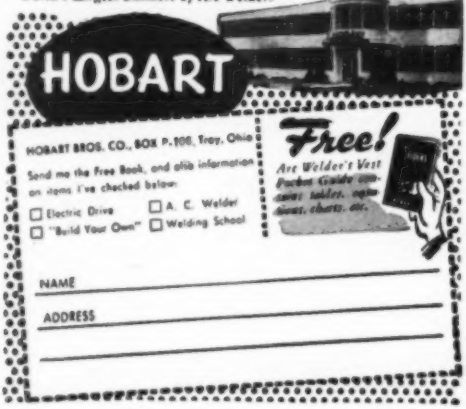
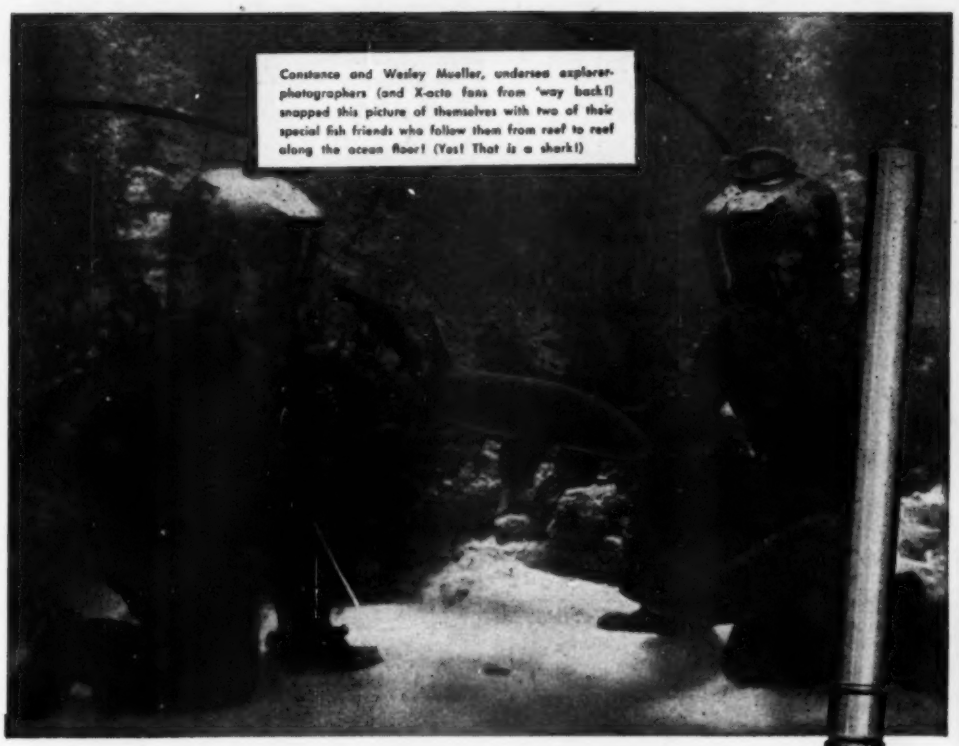


Plastic Raincoat for Hats

A CIVILIAN adaptation of the waterproof hat covers worn by service men during the war is now available. Called Rainat, the cover is made of transparent vinyl plastic film, and is provided in three sizes. An elastic band makes it easily adjustable to various widths of brim. When not in use, the Rainat can be folded to the size of a handkerchief, put in an envelope, and carried in even a small pocket (inset) as insurance against sudden rain. Nearly any size of man's hat can be protected by the cover.

Tiny Selenium Rectifier

THE new selenium postage-stamp size rectifier developed by the Federal Telephone and Radio Corp., Newark, N. J., has a wide range of uses, including the replacement of as many as 29 different rectifier-type tubes now used in various radio receivers. Advantages include durability, economy in space needs, cooler operation, and no warm-up period.



Constance and Wesley Mueller, undersea explorer-photographers (and X-acto fans from 'way back!) snapped this picture of themselves with two of their special fish friends who follow them from reef to reef along the ocean floor! (Yes! That *is* a shark!)

THEY EXPLORE THE OCEAN FLOOR

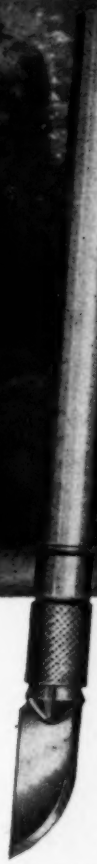
...and find a hundred uses for X-acto

THERE'S never a dull moment in the sea-going life of the Muellers. They run their own 40-foot cruiser, do their own diving, take their own photographs, and coax the "monsters" of the deep to pose for them.

In their laboratory, in designing and repairing their equipment, in preparing their photographs for publication, they "encounter a hundred jobs requiring implements for delicate as well as heavy cutting." And that's a hundred jobs for X-acto! In fact, say these exacting scientists, "X-acto Knives have now replaced a nondescript group of tools we formerly used, because we found them *stronger, safer, keener.*"

13 Blade Shapes Quickly Interchangeable!

Landlubbers, too, find X-acto Knives do their hobby and business cutting jobs, quicker, better and *easier.* With 3 *all-metal* handle styles (*No more substitute plastics!*) and 13 different blade shapes, X-acto is always scalpel-sharp, always ready. Amateurs or experts ... whittlers, model builders, sculptors in paper, wood or plastics ... choose X-acto for fun *and* best results.



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X-acto No. 2 Solid Duraluminum Knife . . . **50c**
With 5 assorted blades, $1. Other X-acto Knives, Tools, Chests, 50c to $12.50.

It's Get Everything! No. 85 X-acto Tool Chest —3 all-metal knives: full assortment of blades; saw; sander; stripper; planer; drills and holders; steel ruler; complete in wooden chests, $12.50.

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X-acto Crescent Products Co., Inc., 440 Fourth Ave., New York 16, N. Y. In Canada: Handicraft Tools, Ltd., Harmant Bldg., Toronto

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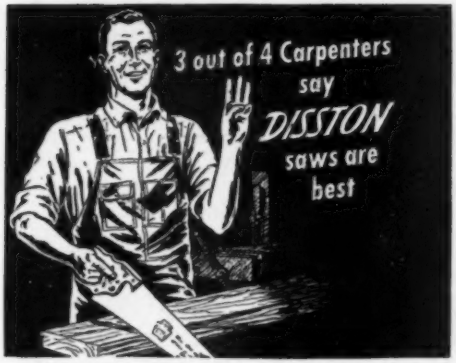

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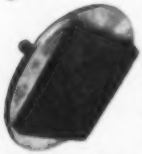

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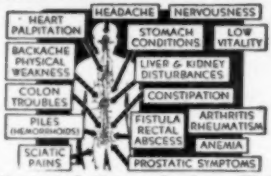

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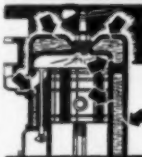

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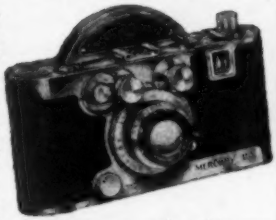

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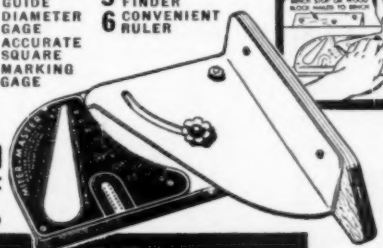

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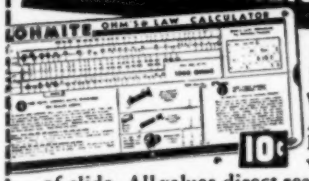

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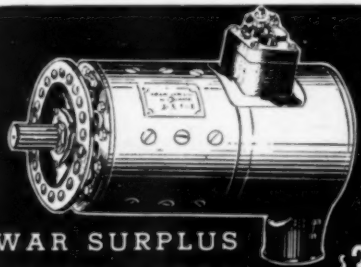

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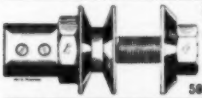

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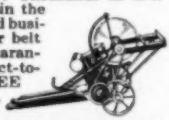

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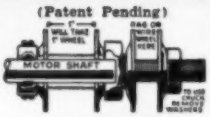

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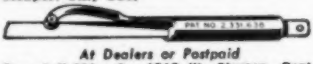

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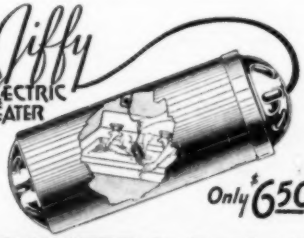

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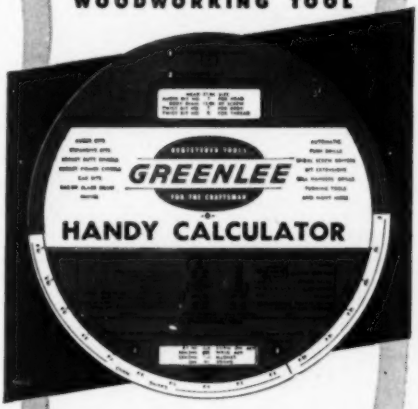

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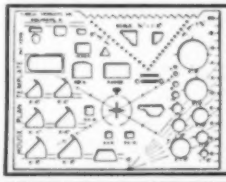

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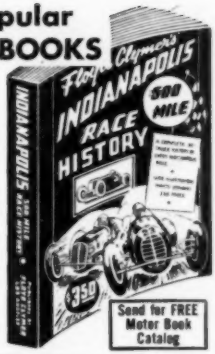

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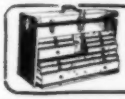

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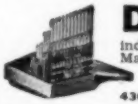

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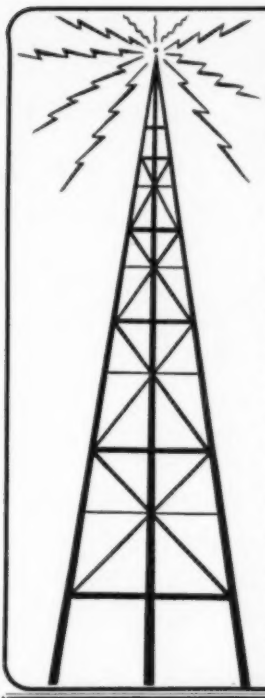

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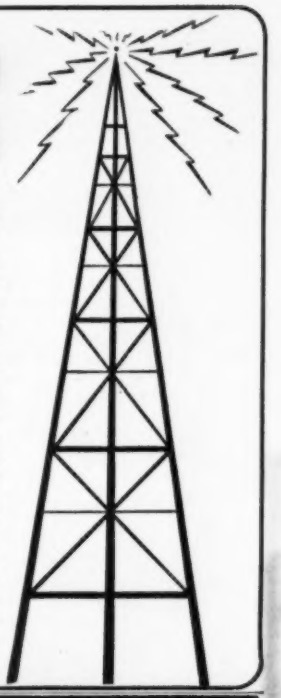

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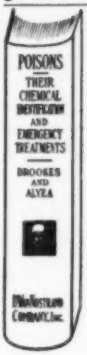

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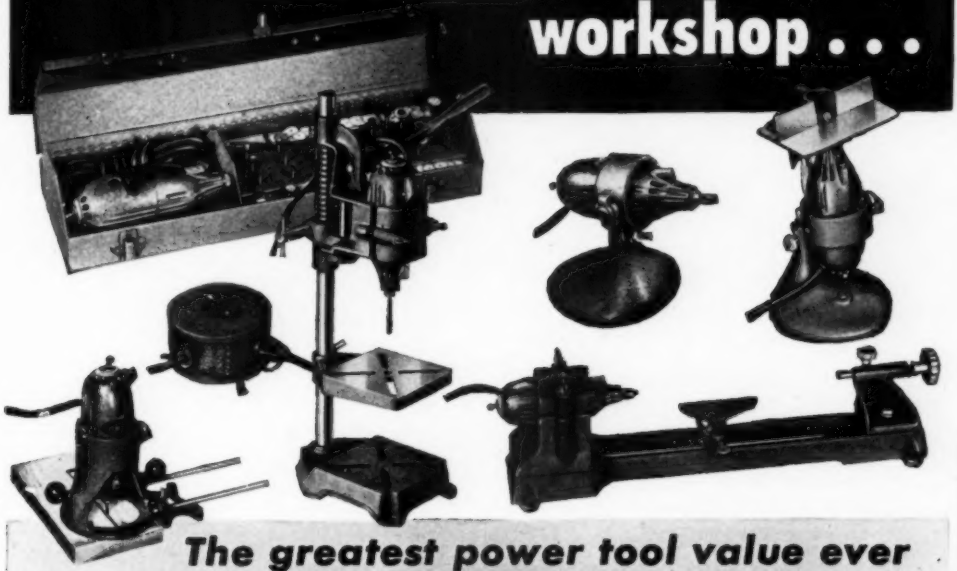

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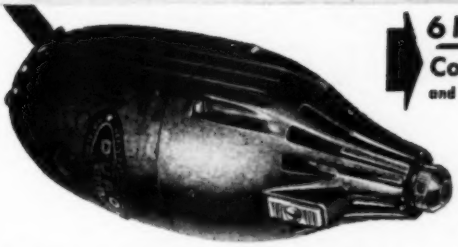

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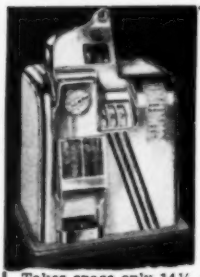

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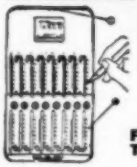

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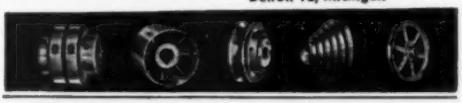

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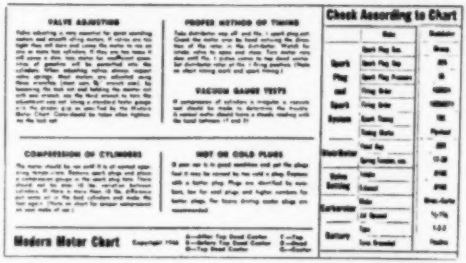

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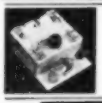

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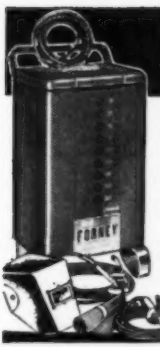

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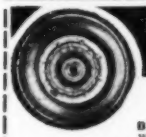

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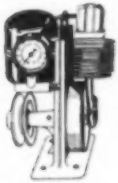

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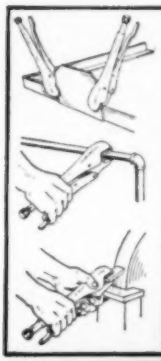

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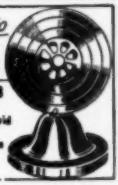

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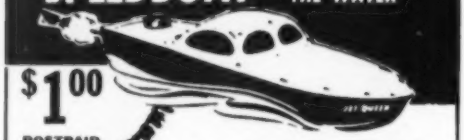

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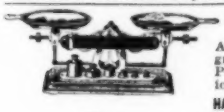

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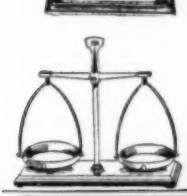

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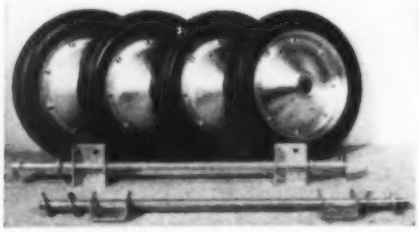

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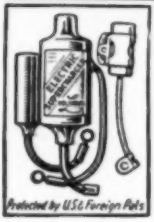

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TO: Reader
FROM: Editor

UNLISTED Editors

IN CARD FILES at the editorial offices of *Popular Science Monthly* are hundreds of names, with addresses and telephone numbers. If we were going to write down a list of assets, these names certainly would be at the top. For they are the names of our friends, people all over the United States who help put out our magazine.

These names don't appear on the masthead, but they contribute to the content each month just as surely as our artists and writers and "copy" men do. They help us get the research material for our stories. They dig into their files for buried facts. They know the value of meticulousness.

Our friends help us prepare drawings and pictures, and sometimes they pose for pictures. Many are readers, but all know PSM and are glad to help us get the facts. They are college professors, prominent industrialists, Army and Navy officers, railroad brakemen, the tool operators in factories, and the public relations officers of business enterprises.

This month we give you a picture of one of our friends. She is Miss Elizabeth Porrecha, who weighs all of 102 pounds soaking wet. Poured into a pair of overalls, she operates one of the multi-ton traveling cranes at the Baldwin Locomotive Works in Chester, Pa. Her fingers are slim but she can handle a 2½-ton drive wheel as easily as a knife and fork.

For some of the pictures in this month's story on locomotives ("More Power on Wheels", p. 66), Miss Porrecha was permitted to halt her mechanical Atlas long enough to lift some locomotive parts into camera range.

"About three inches lower, please," our photographer called to Miss Porrecha on her perch, and down the subject of the photograph came, exactly three inches.

Then we asked if we could take a picture of her too. That took some time. We had to wait until she stopped blushing.

Now her name has been added to the legion of those who help us put out a better magazine for you. And ever the list grows longer. At Bikini were friends who helped us get the first of our reports on the atom-bomb test and then, not content with that, helped us hurry the story through by radio.

For August, friends in Hollywood helped us get the pictures of Montgomery, the glider enthusiast of the 1880's, and of the movie version of his life. For our September issue, friends helped us prepare those splendid drawings that illustrated the article, "Electrons at Work."

Next month you will see the product of the cooperation of some friends of PSM in Detroit, where we prepared an article on packaging human beings in steel. That's really what automobile design amounts to, and our story will tell how they go about it. The designers dropped their work to help us arrange for pictures and basic text material. And many of them spent hours of their own time giving us the background of their business.

That's what we mean by having friends.

Daisy Francis

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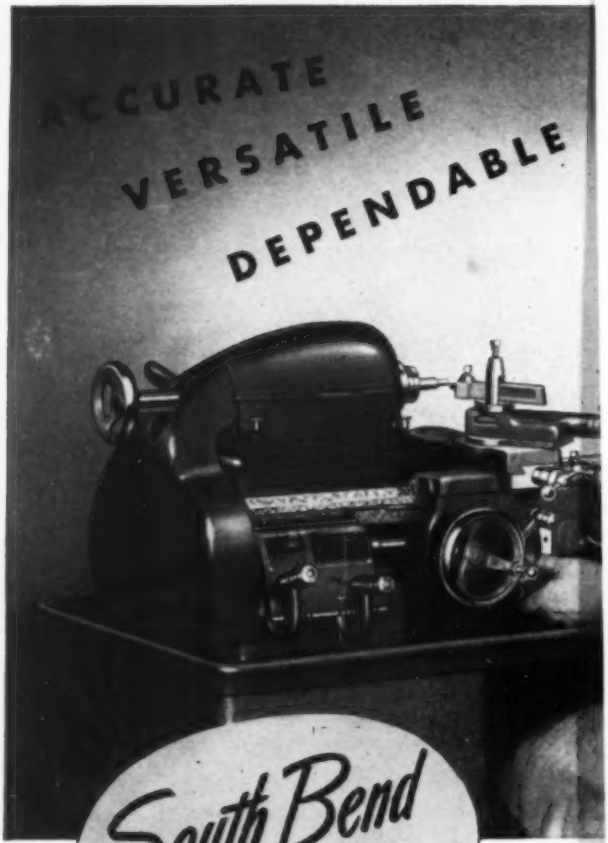

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